MAY 1980 Volume 5, Number 5 $2.50 in USA/$2.95 in Canada

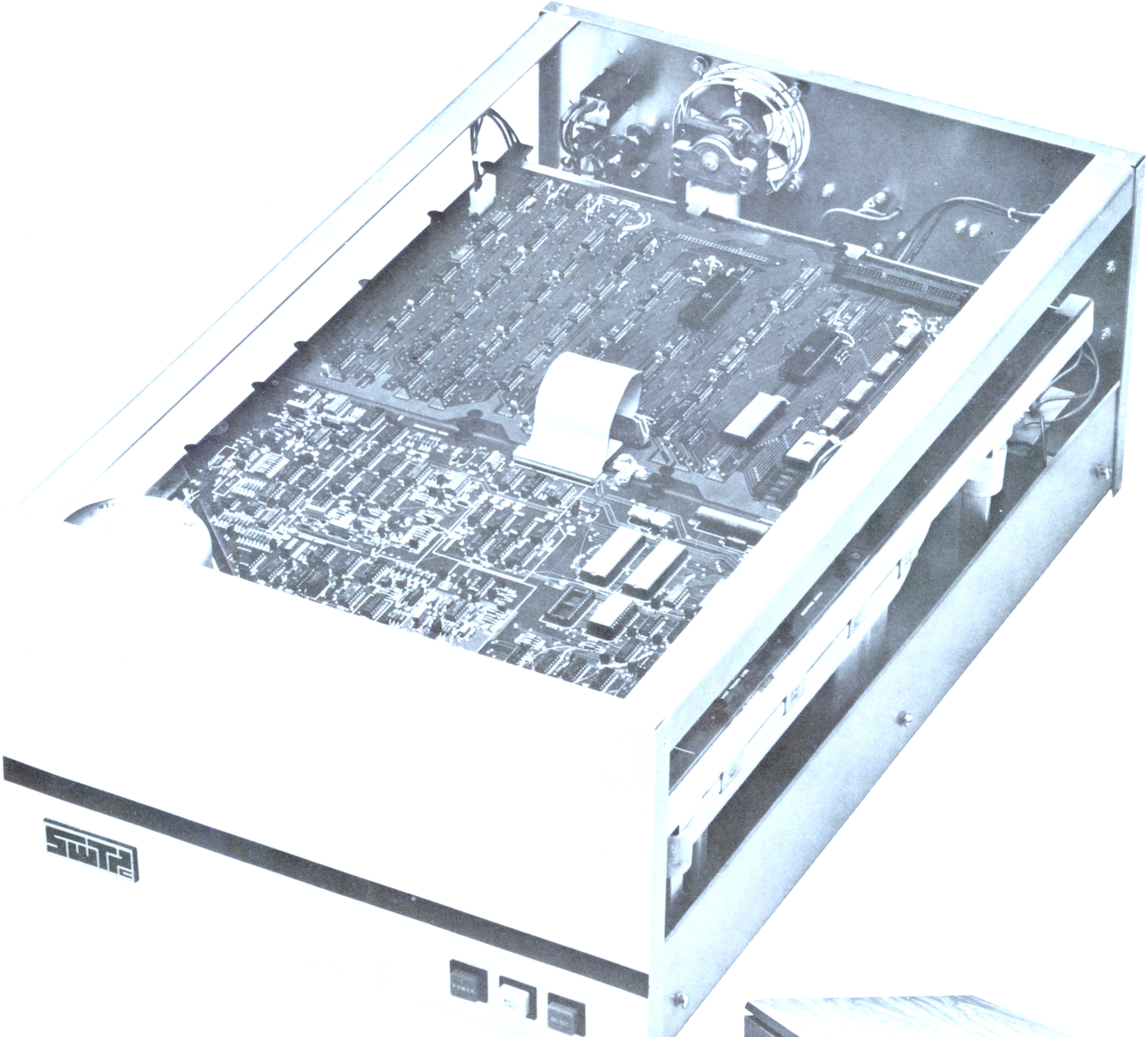
BYTE®

the small systems journal

A McGRAW-HILL PUBLICATION

ROBERT
80 TINNEY

FLOPPY DISKS



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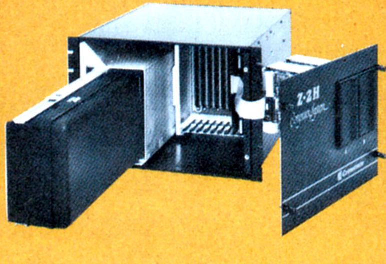

Hard disk drive at lower left can be interchanged just by sliding out and disconnecting plug. Seven free card slots are available. Z-2H includes printer interface card.

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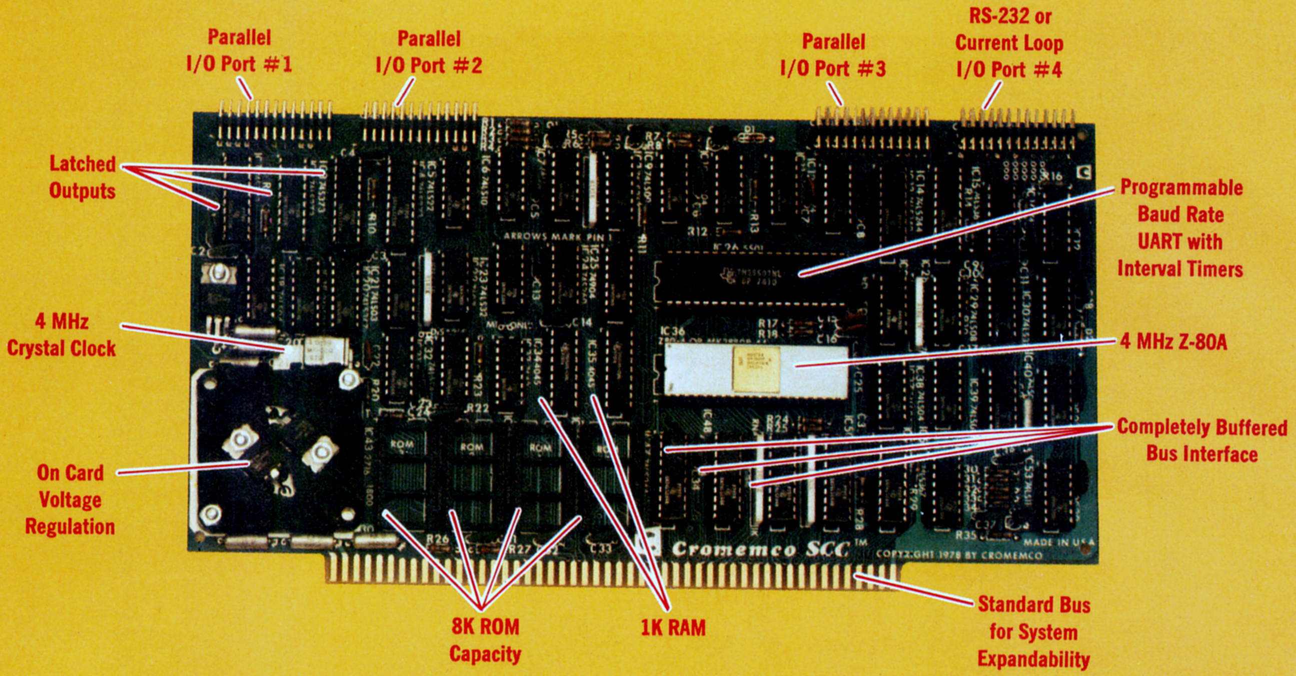
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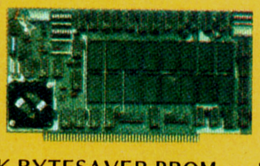

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In The Queue

BYTE May 1980
Volume 5, Number 5

Foreground

20 A DC-TO-DC CONVERTER *by Michael Picco*
Here's a simple converter that uses a standard integrated circuit for producing a 25 mA bipolar source from a single-ended power supply.

22 I/O EXPANSION FOR THE RADIO SHACK TRS-80, **Part 1: Principles of Parallel Ports** *by Steve Ciarcia*
This month Steve explains the operation of parallel input/output as a prelude to next month's design for an economical RS-232C interface.

44 KIMDOS, **Using Your KIM-1 with a Percom Floppy-Disk Drive** *by Joel Swank*
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72 INTERFACE A FLOPPY-DISK DRIVE TO AN 8080A-BASED COMPUTER *by John Hoeppner*
Building a disk-controller board for a Shugart SA400 disk drive can be done easily and with commonly available parts.

196 GIVE YOUR COMPUTER AN EAR FOR NAMES *by Tom Munnecke*
With the Soundex code, you can locate people's names in your data base by similar, but not exact, spellings.

214 THE COSMAC DOODLER *by Jeff Duntemann*
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250 ERROR CHECKING AND CORRECTING FOR YOUR COMPUTER *by Gregory J Walker*
Storage devices can introduce data errors. The system presented here can increase reliability and speed of these peripherals.

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12 THE CASSETTE LIVES ON, **An Alternative to Floppy-Disk Mass Storage** *by Emory Cook*
Floppy disks may be the glamorous way to store programs and data, but the cassette is far from obsolete.

104 A GRAPHICS TEXT EDITOR FOR MUSIC, **Part 2: Algorithms** *by Randolph Nelson*
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120 USING THE COMPUTER AS A MUSICIAN'S AMANUENSIS, **Part 2: Going from Keyboard to Printed Score** *by Jef Raskin*
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130 COMPARING FLOPPY-DISK DRIVES BY SOFTWARE SIMULATION *by Dennis Nendza*
Now you can get some idea of the relative performance of different units by simulating their mechanical functions in a BASIC program.

202 THE CLUB COMPUTER NETWORK *by Joe Kasser*
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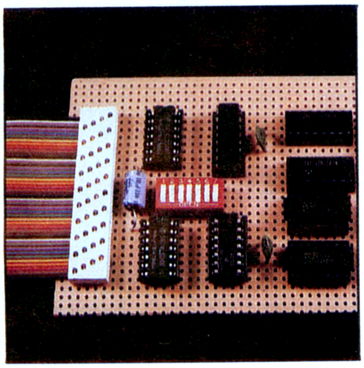
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ON LAST MONTH'S COVER

The April cover, which has received so many compliments, was a creation of the photographic artistry of Ed Crabtree. Ed is a professional commercial photographer in Peterborough, N H and has been BYTE's photographer from day one. This was Ed's first BYTE cover. We're sure it won't be his last.

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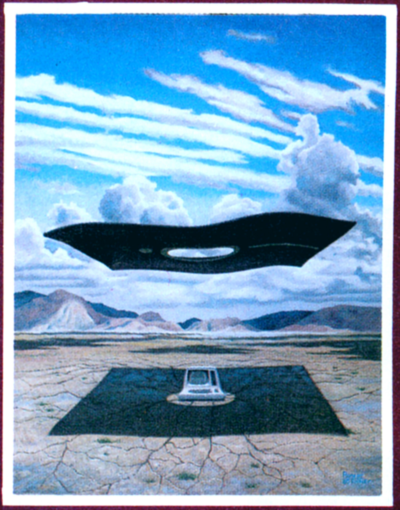

ON THE COVER

On May's cover, Robert Tinney has formed an abstraction of the most important medium of mass storage in today's era of small computers, the floppy disk. Heightening its shimmering mystery, we find a disk wavering in the heat above some desert landscape. To enlighten you, this issue features several articles that present valuable information about floppy-disk technology. This technology is no mirage — it will even work well in a similar, hot environment of East Africa, as the editorial on page 6 describes.

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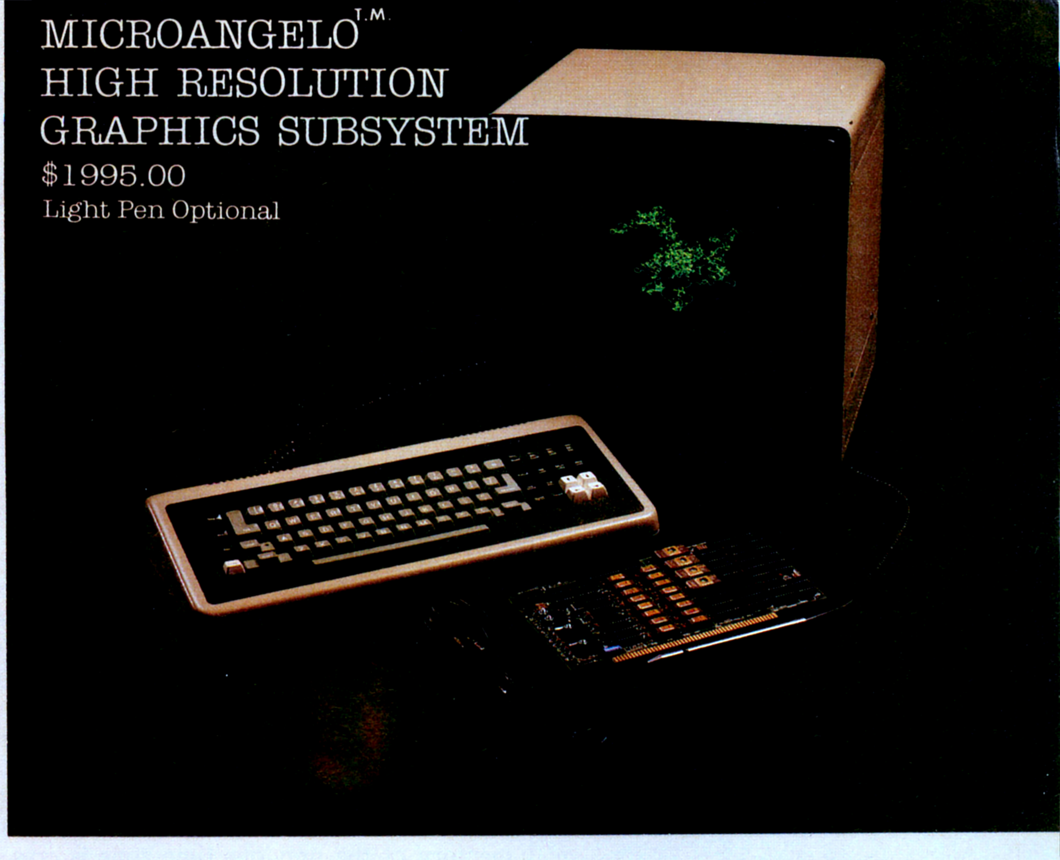

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Shugart

Editorial

Computer-Controlled Viewing of the 1980 Eclipse

by Carl Helmers

As noted in the March 1980 editorial, I traveled to Kenya in East Africa to observe the 1980 total solar eclipse with an Apple II Pascal system controlling the photographing of the event. This month's editorial is a commentary about the experience. This commentary was written upon my return to New Hampshire a week after the eclipse.

The final preprations for the Kenya eclipse of 1980 were made in an intensive session of 24-hour workdays, February 2, 3, 4, and 5. One physiological consequence of no sleep for 3 or 4 days is that when traveling through 8 time zones there is no possibility for jet lag! One's body is so tired that all memory of the previous time zone is erased completely. Norm Whyte and Laurel Allen, who coordinated many of the details of the trip to Kenya, arrived in Boston from California on the second of February and spent the weekend at my home. During this final weekend's activity, we each had several chores to finish. One detail, for example, was making sure that both computers would operate simultaneously off Norm's portable Honda AC generator. Another was adding a hardwood extension to Norm's telescope mount so that my camera could be attached along with his.

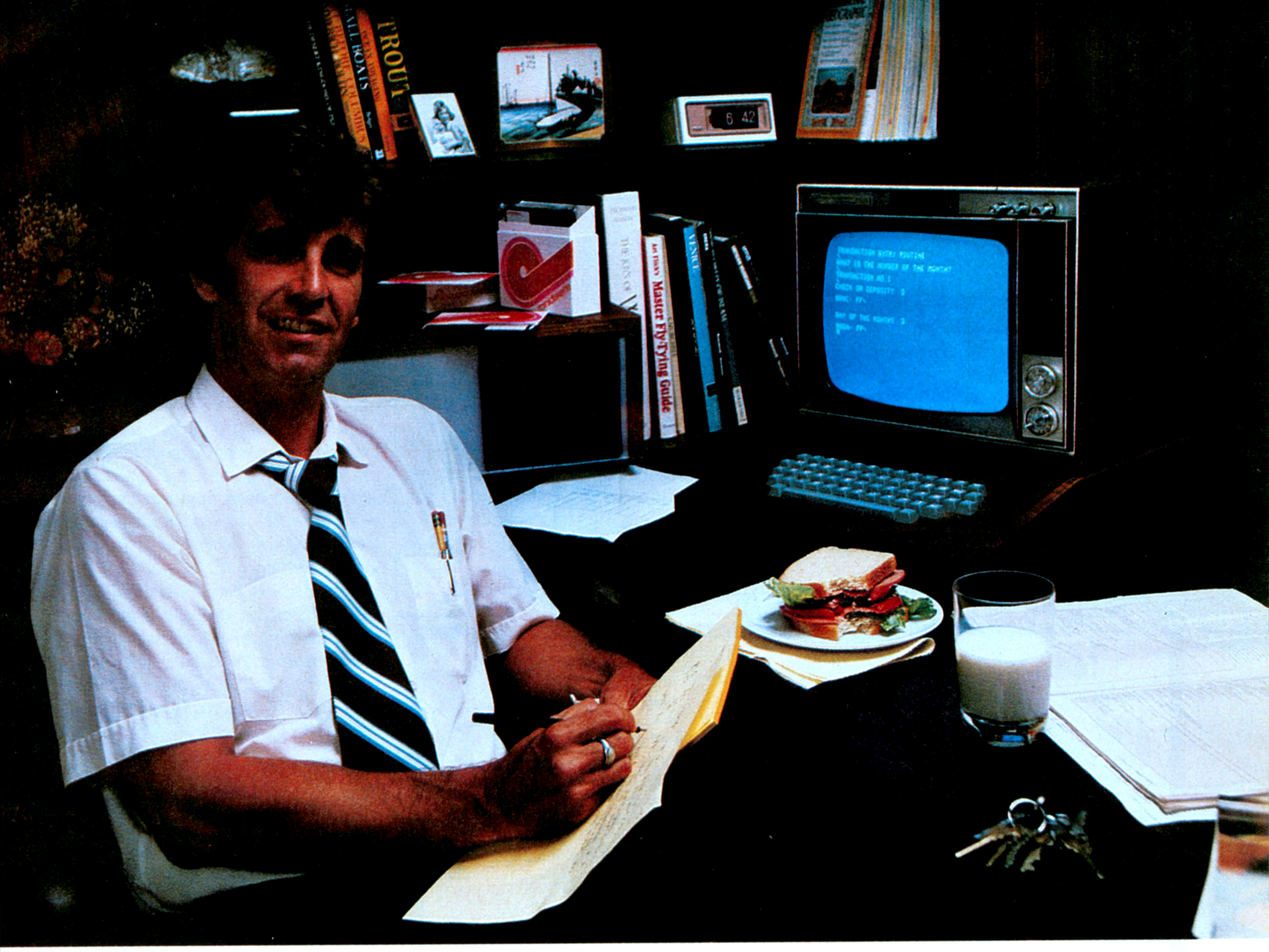
In connection with the program design of my experiment, a number of crucial points had to be verified. With the time allocation procedures completed as described in the March 1980 editorial, writing the real-time procedures to execute the time line proved trivial. These were the procedures left in dummy form in the listing 1 published with the March 1980 editorial. In listing 1 accompanying this editorial, readers will find the final form of the program I used. In approaching this final form I implemented the execution routines using a module named "milli" to carry out time delays of an integer number of milliseconds. The program itself was verified by driving the camera interface using a first approximation to "milli" in the form of Pascal dummy loops used to count time.

Originally I hoped that (by fortuitous circumstance) I could use some combination of Pascal statements in a loop to provide time delays in units of milliseconds. But, after perhaps an hour of fooling with various combinations, I came to the conclusion that this would not be possible. I was either 6% too slow or 6% too fast depending on whether or not I put a unary negation in a timing loop's dummy assignment statement.

Since program development time was limited by a departure schedule, it soon became apparent that the lesser of two evils (imprecision or assembly language) was to write an assembly-language routine called "milli" that links to Pascal with a single integer parameter specifying a loop delay time in milliseconds. I finished this necessary step sometime in the wee hours of February 4. I checked the accuracy with various simple test programs written in Pascal. Of course, my timing assumption was that zero time would be spent outside of "milli" executing the Pascal code of the actual program. This assumption was verified with test runs of the whole eclipse photography sequence, which showed about 1% error. By adjusting the constants in the delay routine slightly, this error was compensated at the gross level of the entire eclipse sequence's 241-second execution time.

Text continued on page 52

"My Shugart followed me home."



"After working all day with the computer at work, it's a kick to get down to Basic at home. And one thing that makes it more fun is my Shugart minifloppy™. We use Shugart drives at work, so when I bought my own system I made sure it had a minifloppy drive.

"Why? Shugart invented the minifloppy. The guys who designed our system at work tell me that Shugart is the leader in floppy design and has more drives in use than any other manufacturer. If Shugart drives are reliable enough for hard-working business computers, they've got to be a good value for my home system.

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"I made the right decision when I bought a system with the minifloppy. When you lay out your own hard-earned cash, you want reliability and performance. Do what I did. Get a system with the minifloppy."

If it isn't Shugart, it isn't minifloppy.

Shugart
435 Oakmead Parkway, Sunnyvale, California 94086

See opposite page for list of manufacturers featuring Shugart's minifloppy in their systems.

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Letters

Information on Potter Printer Needed

Can a reader of BYTE help me? I recently purchased a printer from salvage, and I hoped to obtain documentation and a schematic diagram from the manufacturer.

The printer is a Potter Model LP-3000, manufactured by the Potter Instrument Company, formerly of Plainville, New York. I called the firm, and I was told:

1) The company is in the process of moving to New Hampshire.
2) This particular model of printer is obsolete.
3) They have no documentation or schematic for this model.

From my examination of the circuits and machinery, I believe the Potter LP-3000 is a daisy-wheel type with a serial data input. However, whether it uses ASCII or not, I can't tell.

Can someone tell me how I can interface this printer to my Radio Shack TRS-80 Model I Level II computer with expansion interface?

Nick Tountas
838 Juniper Rd
Glenview IL 60025

Questioning "Affordable"!

When you are on Social Security, an affordable computer system that costs $6000 is like "# @ * "! When your monthly income is $360, to have an editor smugly talk of plunking down $6000 cash as if it were a minor outlay tends to be *very* irritating.

On top of that, the system Mr Helmers described is just the sort (with minor modifications) I have wanted for ages. Another thing that hurts is the industry-wide disinclination to even consider time payments or credit. I know that I'll have to wait, and probably wait over 5 years, but maybe not. If I were just disgusted with your editorial, I wouldn't have bothered to write. What I would like to know is if any BYTE reader knows of a way I can obtain such a system as Mr Helmers described — perhaps secondhand — without paying thousands of dollars cash? By squeezing, I can afford $100 a month now, and by July I should be able to afford $150 a month, perhaps more.

In a way, I have to thank Mr Helmers for that editorial. It made me mad enough to write, and perhaps there is a solution to my problem.

Fred J Remus Jr
POB 2453
San Diego CA 92112

Carl Helmers Replies

Give the industry time. Five years ago, the same system might have been well in excess of $30,000, with inferior programming languages and comparable on-line storage capacity. Tremendous strides have been made in the past 5 years, and we can expect a certain leveling-off of prices in the future as mass production at 100,000 unit levels per year starts becoming reality. And then, of course, one looks at it from the point of view of increasing demand for these products. If we do not write about the conception of a good machine, we have no interest on the part of users.... CH

Gomoku

I was interested in the "Programming Quickie" by John Allwork ("BASIC Game: GOBANG," November 1979 BYTE, page 56) for Gobang is also called "Gomoku." There has been a competition running for Gomoku programs since 1975; I am the current champion. People interested in the contest should contact:

Shem Wang
Dept of Computer and Information
Science
University of Guelph
Guelph, Ontario, CANADA

So far my different programs have run on large mainframe computers, but I hope to have one working on my North Star microcomputer for the next round of competition.

Mike Compton
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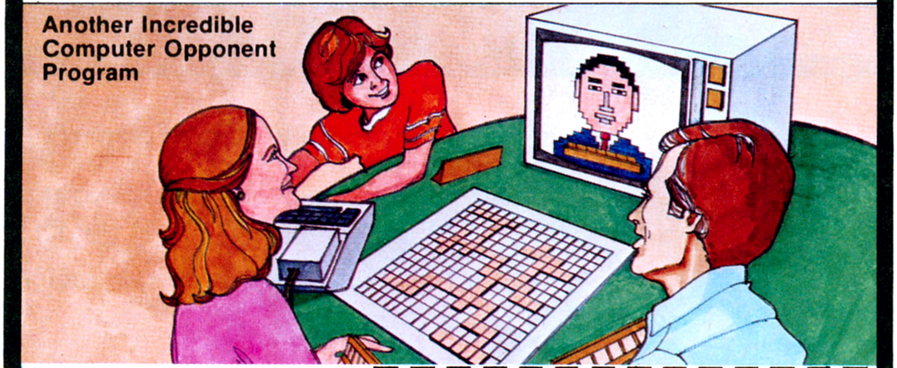

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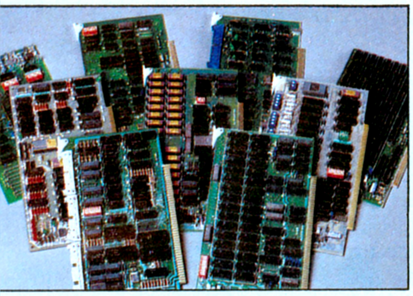

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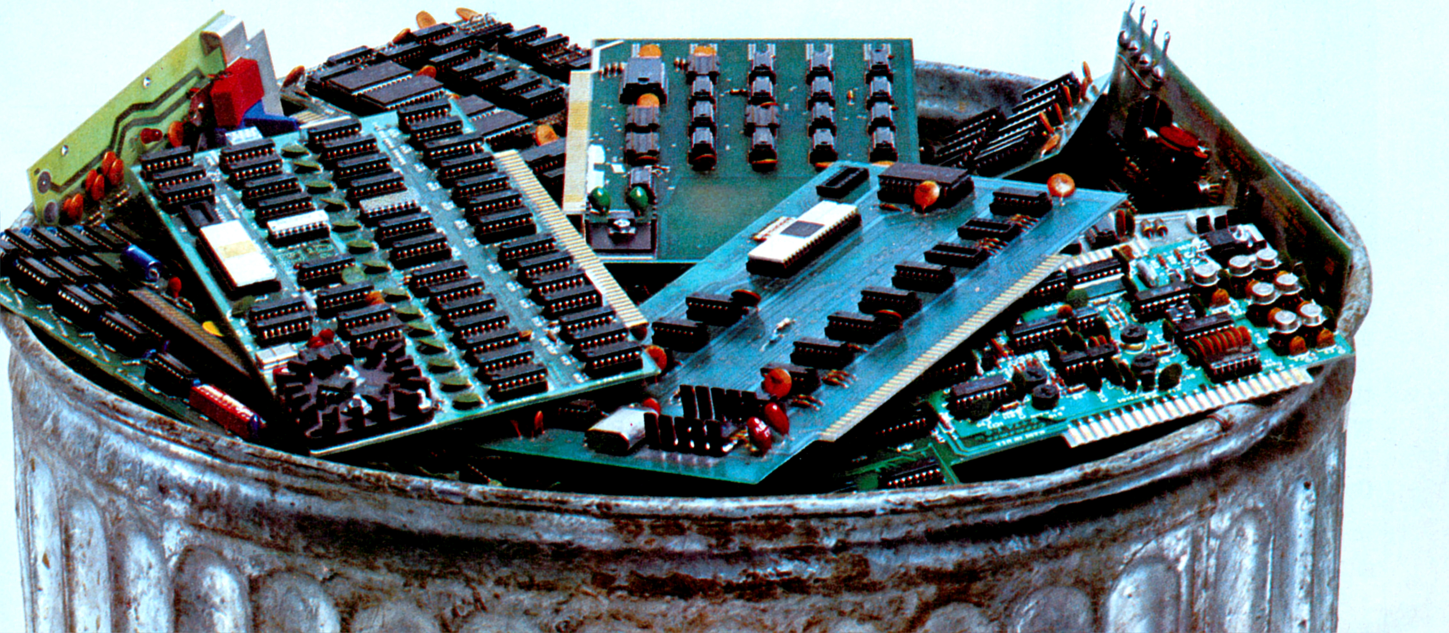

Searching for FORTRAN Compiler

I am an avid reader of BYTE and I believe that one of my fellow readers may be able to help me with a problem.

My school is thinking about expanding the courses that are offered in the area of computer science. It is hoped that an extensive course in FORTRAN programming may be offered.

Our computer is a CIP/2200 manufactured by the Cincinnati Milacron Corporation. It has a small disk-operating system and a card reader. The word size is 32 bits, and, at this point in time, the memory size is 32 K bytes. There are plans, however, to expand the memory to 64 K bytes by the time the FORTRAN course is offered.

My problem is that the Cincinnati Milacron Corporation does not make a FORTRAN compiler for our machine. I would like to know if any reader of BYTE could suggest any companies that might sell a compiler that is compatible with our machine.

Daniell B McCormick
Box 675
Presbyterian College
Clinton SC 29325

Seeking Computers for the Blind

Does any reader of BYTE know of a source for a computer system that uses audible output instead of characters displayed on a terminal for its customary interaction with the user, such as that produced by the Votrax speech interface? Such a computer system would be used by blind people. It would be desirable if a BASIC interpreter that used audible output were included.

If anyone has or knows of such a system, please contact me.

Walter F Keleher
56 Robin St
Rochester NY 14613

Altair BASIC Patch Needed

I wonder if any BYTE readers could assist me in locating the patch to Altair 8 K 4.0 Version and Altair Extended 4.0 Version BASICs which will allow these BASICs to run on a Z80.

I recently purchased a TDL ZPU which uses the Z80. The manual notes this incompatibility stating that Altair BASIC "has as part of its routines several occasions where the parity flag is checked as part of the function. In the Z80 the parity flag indicates OVERFLOW during math routines, not parity." The manual states that it contains a patch in Appendix C, but no Appendix C is included.

If any reader of BYTE knows where this patch may be obtained, please let me know.

Hugh Morgan
7725 Berkshire Blvd
Powell TN 37849

Pascal Examples Needed

Just a short note to tell you how very much I appreciated Carl Helmers' "Pascal Checkbook Balancing Program" which appeared in the January 1980 BYTE.

As a beginner, I don't think he "*profaned* Pascal by writing a simple little ..." etc. The program was *most informative*, and I studied it in detail. I have adapted it to the formulation of a metrics conversion program. It was certainly clearer than most of the program examples in the few, but confusing, texts on Pascal.

I realize that in general BYTE magazine caters to the experienced programmer, but what we need are more examples like yours—the we being those of us relatively new to the art.

So thank you once again—and *please* some more tutorials and programs!

Max Nareff
5235 Diamond Heights Blvd
San Francisco CA 94131

A Satisfied Reader Comments

I couldn't believe it! Ted Carter's article "Implementing Dynamic Data Structures with BASIC Files" (February 1980 BYTE, page 92) was exactly what I needed for a program I am writing to computerize billing on a newspaper route.

I had tentatively planned my file routines, but I scrapped my ideas after reading the article.

James E Nichol
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Cincinnati OH 45224 ■

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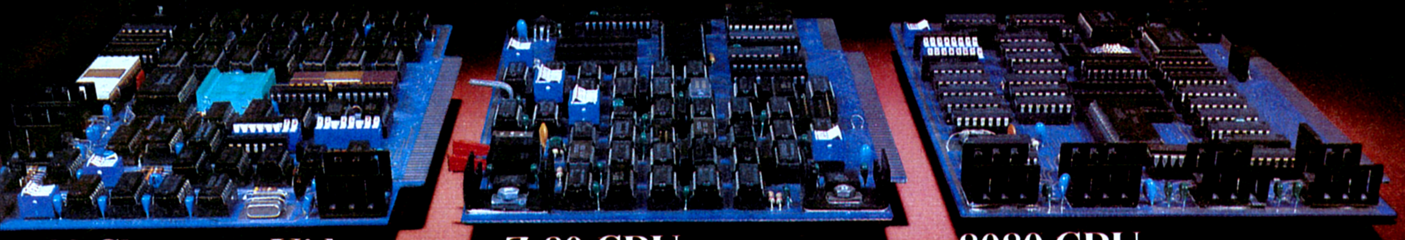

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VB3 is memory mapped for rapid screen updating. But it occupies memory only when activated. So one or more VB3s can be located at the same address with a full 65K of memory still available to the user.

It generates both U.S. and European TV rates and meets the new IEEE S-100 standard. Other features include keyboard input, black on white or white on black, one level of grey, underline, strike thru, blinking char., blank-out char., and programmable cursor. Software includes a CP/M compatible driver and a powerful terminal simulator.

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The Cassette Lives On

An Alternative to Floppy-Disk Mass Storage

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In a world where floppy and hard disks are becoming more affordable for the average small-business user and hobbyist, sequential mass storage in the form of cassette tape is gaining disfavor. Still, many disk users get into trouble when something happens to a floppy disk and they have *not* made backup copies. Although any backup system requires the time and inconvenience of regularly carrying out the file-copying procedure, one problem with using floppy disks for file backup is the cumulative cost of the number of disks needed to maintain backup copies of all records.

The Cassette Solution

What is needed is a low-cost filing medium. Cassette storage is the answer, provided we take the necessary precautions to make it reliable. Old files, such as files of records for last quarter, last year, and the years before, *belong* on cassette. The disk-to-cassette transfer for backup purposes becomes sensible in terms of both expense and security. With adequate tape recorders and high-quality cassette tapes (which use both quality tape material and quality mechanical housings) cassette storage can and does become highly dependable.

Let's go a step further. Anyone who is using a microcomputer and needs its daily functioning will be acquiring a spare microprocessor. With a three-head, audio-cassette machine,which has a separate playback head following the record head (a common piece of high-fidelity equipment), the spare microprocessor can readily be set up with a machine-language program. This program verifies a backup tape by reading the information immediately as the tape is written. [*The same result can be accomplished (a bit slower, however) for those of us who cannot afford a spare microprocessor board or an expensive cassette recorder. This can be attained by using a verification program running on the same microprocessor to reread the newly created tape and compare its information with the contents of computer memory....*GW]

Floppy disks may be a glamorous way to store programs and data, but the cassette is far from dead.

When records are backed up at the end of some reasonable period (ie: day, week, month, etc), the extra time needed to dump the records to cassette at a low transfer rate is not an overwhelming disadvantage. A second backup tape simultaneously made with a second recorder is always a good idea. In other cases, one cassette copy can simply serve as a backup for printed records, thus saving time, printer wear, ribbons, and paper.

For even the most inexpensive cassette deck, a small amount of money and attention can result in the following:

- excellent performance and reliability (no more trial-and-error adjustment of the volume control)
- a very low error rate (statistically as good as that of a 5-inch floppy disk)
- the lowest possible cost per bit stored

Problems with Cassette Storage

The main problems with currently used cassette-storage methods are dirt, variation in tape speed, problems with azimuth alignment, and inferior tape quality.

Dirt collects on the tape recorder head from several sources, from the room, from dust left on poorly manufactured tapes, and sometimes from sweaty fingers attempting to wipe the head clean. The tape head and the pressure roller can be cleaned using pure alcohol and a cotton-tipped swab.

Periodic cleaning is imperative when using poorly manufactured tapes. Cassette tapes are manufactured by slitting a 30.5 cm(12-inch) wide sheet of magnetic material called a *web*. Slitting is accomplished with knives, which often get dull from cut-

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ting the inherently abrasive magnetic coating. If the knives are not periodically sharpened (which is the case in making some inexpensive cassettes), the dull knives cause a fine powder of magnetic coating to collect on the edges of the tape. As a result, abrasive magnetic powders come in contact with the tape head when the cassette is later played. The poorer the quality of the tape, the greater the chance that this is occurring.

Variation in tape speed can be caused by belts slipping within the cassette recorder, but it is more often caused by flaws in the pressure roller, which with the capstan is meant to push the tape through the machine at a constant speed. Leaving the tape recorder set in play mode with the motor disengaged (as is done in several current personal computer systems that let the computer control the tape motor) may eventually cause indentations on the pressure roller, with some inevitable variation in tape speed. This variation impairs the reliability and the data-transfer rate of the cassette interface, so it is important to keep the pressure roller clean at all times and disengaged when not in use.

Azimuth of the tape head refers to the angle between an imaginary line drawn in the direction of tape movement and the vertical, magnetic gap on the record/playback head of the cassette recorder. This angle should be 90°-that is, the tape should run straight across the tape head, perpendicular to the magnetic gap. If the tape head is somehow knocked out of alignment (which happens frequently, although nobody knows how), it must be restored if the tape recorder is to faithfully play back a recorded tape.

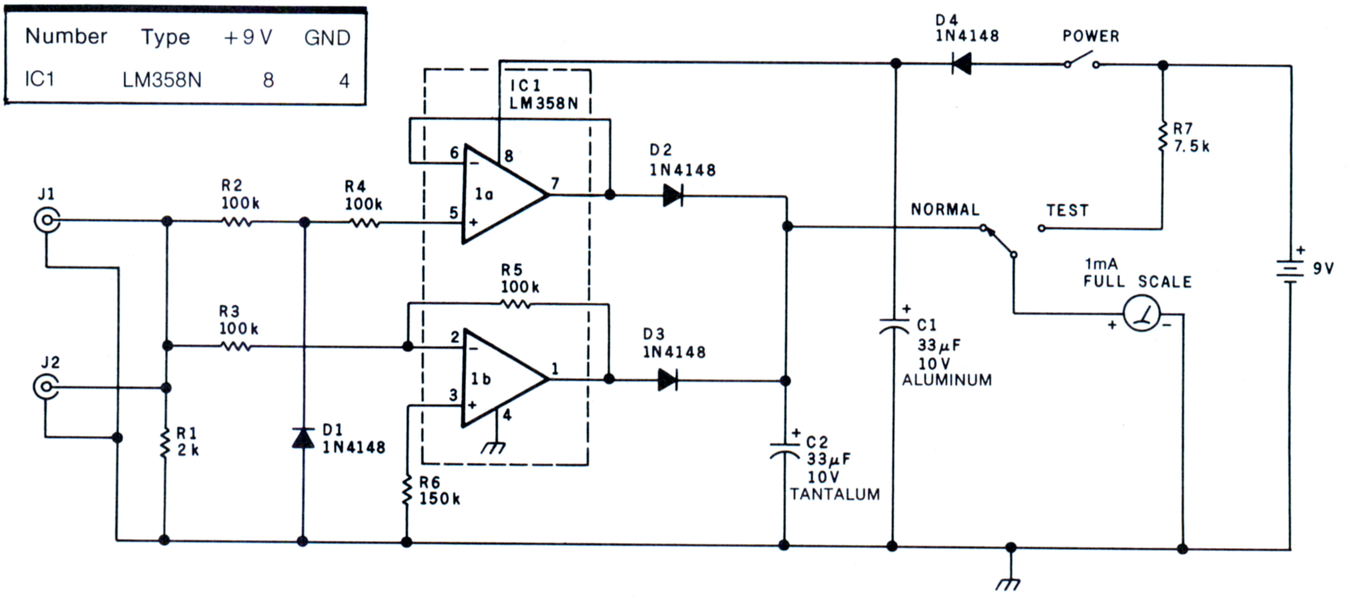
There is an adjustment mechanism, usually a small Phillips screw, on the left-hand side of most tape heads. However, some tape recorders do not allow you to reach the mechanism when the recorder is in the play mode. Because of this, it is important to do one of two things: either buy a cassette recorder that has an azimuth access hole, or have a good craftsman carefully drill a hole over the screw so that it can be reached with a tiny screwdriver when the recorder is in the play mode.

Recording with a Peak-Signal-Strength Meter

It is the peak output, *not* the average or the root-mean-square value of the cassette signal, that most tape interfaces are sensitive to. In order to repeatedly load cassette tapes on the first try, you must be able to send a signal of known strength to the cassette interface. However, most computer systems give us no feedback on cassette signal strength—in other words, we are operating "blindly." Let us use the TRS-80 Level II tape format as an example. The cassette input port terminates within the TRS-80 with a resistance of 100 ohms. A signal from the cassette with a peak level of about 2 V is needed to insure a correct load. If the cassette record/playback head is correctly aligned with the tape, and the signal is adjusted (via the volume control and our peak-signal-strength meter) to a peak level of 2 V, then the TRS-80 (or whatever computer you have) should load correctly every time.

Figure 1 presents the circuit for a peak-signal-strength meter. The signal from the cassette recorder comes in jack 1 and goes out jack 2 to the computer. Two halves of an LM358N dual operational-amplifier device are used to create a circuit that is highly sensitive to voltage changes in the 2 V region.

Although component layout is not critical, a full-size, printed-circuit-board pattern for this circuit is given in figure 2. A 9 V transistor radio battery will have a life of around 2000 hours of continuous use. The unit can be calibrated by marking the milliammeter dial while applying a known voltage from a DC 1.5 V flashlight battery cell; the reading should not change significantly when the polarity of the input voltage is reversed. The circuit is reasonably accurate in measuring peak voltages of signals with a frequency of up to 20 kHz, and it will then give good accurate readings as long as the 9 V battery supplies 5 V or greater.



Number	Type	+9 V	GND
IC1	LM358N	8	4

Figure 1: *Schematic diagram of peak-signal-strength meter. This meter enables the user to present the cassette interface with a signal of known peak intensity—usually, about 2 V. The circuit is designed to be sensitive to voltage changes around the 2 V area.*

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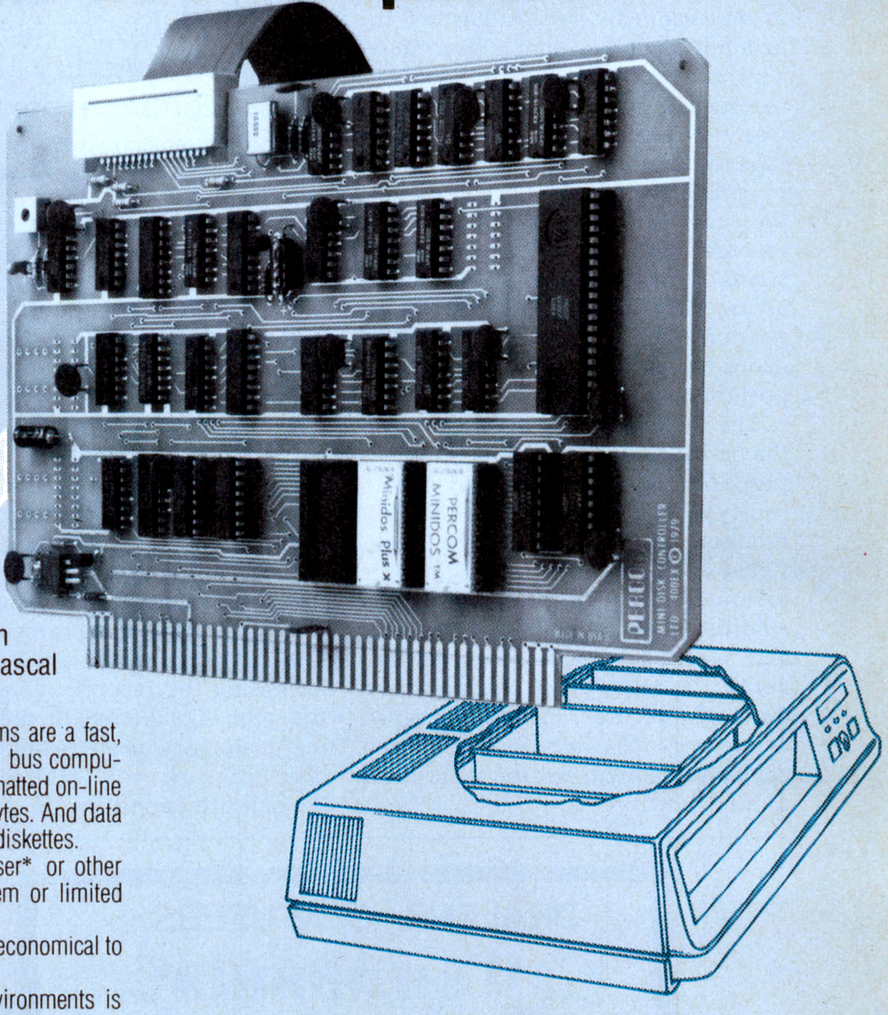

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Checking the Recorder Azimuth

If your tape recorder has an azimuth-adjust screw, adjusting the azimuth angle is a simple procedure. You must first place in the cassette recorder an azimuth-calibration tape (see text box) or a similar cassette tape recorded on a machine *known* to be properly aligned. Then, playing the cassette and monitoring the recorder output with the peak-signal-strength meter, turn the azimuth-adjust screw until the meter reaches its maximum reading. The reading drops off on both sides of the optimal position.

The meter can also be used to get the best reading from a tape that was produced on a tape recorder with faulty head alignment. Simply monitor that tape with the peak-signal-strength meter, adjusting the azimuth-adjust screw until the recorder gives the strongest reading, and use the recorder to load and verify the tape. Once this has been done, the recorder can be realigned and a new tape can be made that you can later load without the same kinds of adjustment.

> One method of improving the reliability of cassette tapes is to modify the signal coming from the cassette recorder.

Problems with Reading Tapes

With most computers, you will need to load a tape using an input peak-signal level of about 2 V (which will appear as about half-scale on the milliammeter of the peak-signal-strength meter). With only slight variations due to a particular computer/recorder combination, the same reading from the peak-signal-strength meter will result in effective loads. A cassette tape coming from a recorder with a misaligned head will give a lower reading than a correctly recorded tape for the same volume setting.First try to load the tape after increasing the recorder volume until the peak-signal-strength meter gives the customary peak reading. If this does not work, you will have to load the tape after adjusting the azimuth in the manner previously described.

Whenever the tape head is misaligned with respect to the tape path, the peak-signal intensity will flutter, even if the tape being played was recorded correctly. This effect is called *skew*. If the signal variation is severe enough, you will be unable to load the tape properly due to data dropout. Signal flutter due to skew is a subtle problem; it will not show on a meter because no meter needle can move fast enough to follow the flutter.

Flutter can also be caused by *tape weave*, which has a variety of causes If the pressure pad opposite the record/playback head is not positioned properly, it will tend to push the tape away from the center of the head. This is aggravated by the fact that most cassette recorders do no maintain tension on the supply reel, allowing the pressure pad to pull out tape freely and push the tape away from the center line of the head. Also, a tape with a thin backing is more susceptible to tape weave.

Altering Tape Waveforms

Another method of improving the reliability of cassette tapes is to modify (and sometimes rerecord) the signal coming from the cassette recorder. For example, severa waveform-changing interfaces that improve the loading reliability of the cassette are available for the Radic

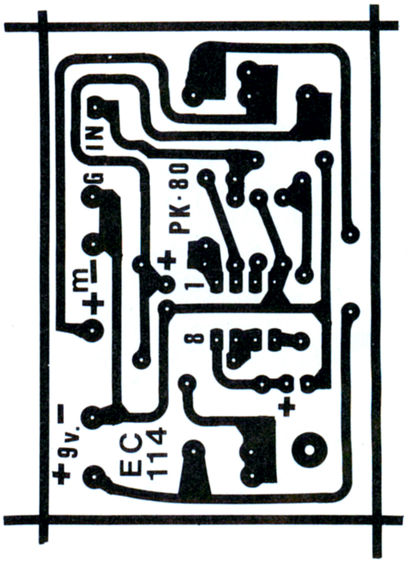

Figure 2: *Full-sized, printed-circuit-board pattern for the peak-signal-strength meter circuit of figure 1.*

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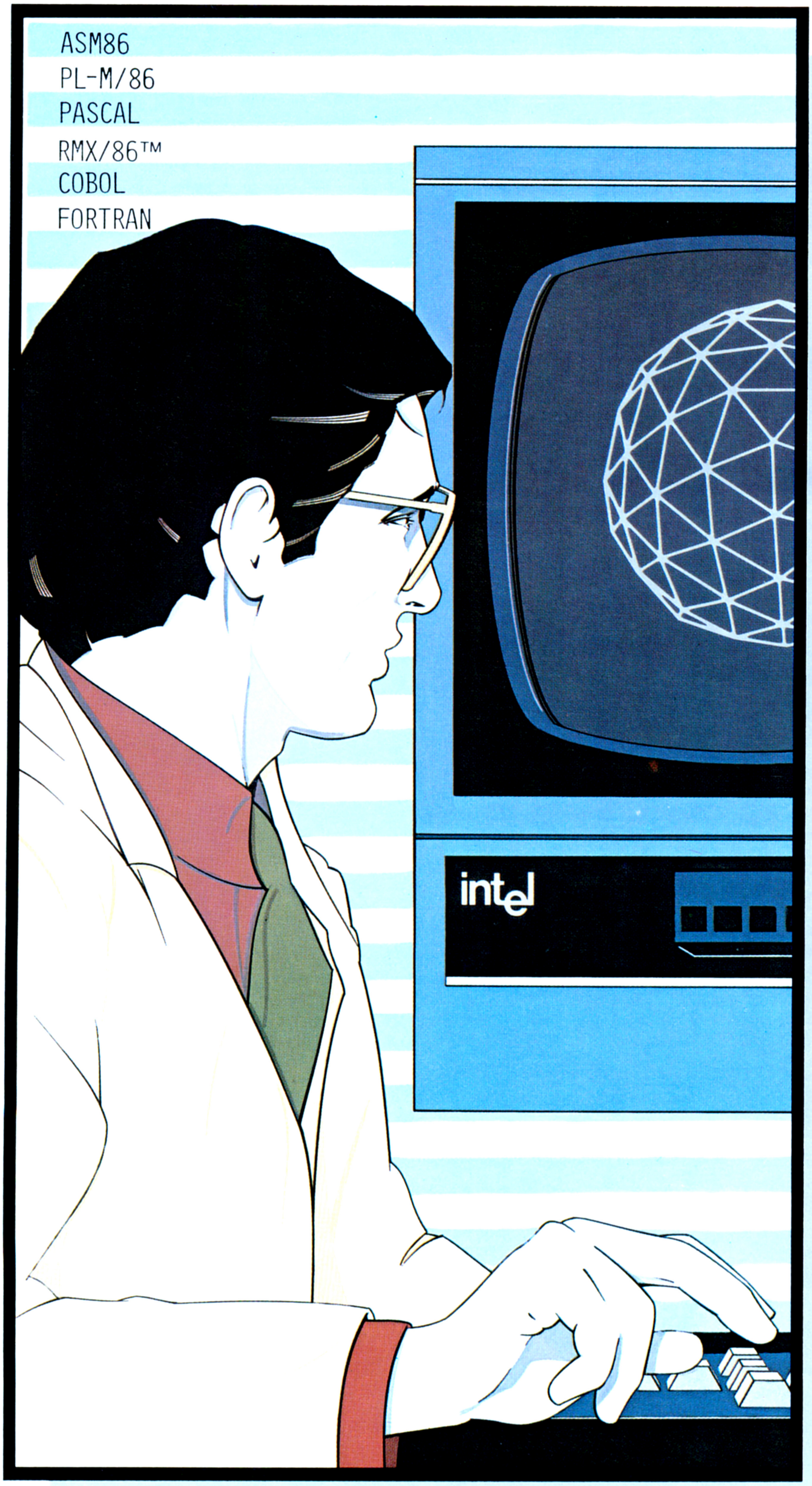
Tools to solve the



How Intel delivers the key to productivity in the '80s.

As we move into the '80s, the increasing demand for complex computer programs, the critical shortage of programmers, and the seemingly unstoppable rise in software development costs will reach crisis proportions. To understand how to bring this situation under control, we have to understand its cause.

In the 1970s, the microcomputer was used successfully to lower the cost of hardware engineering. Each new microcomputer generation integrated more and more of the system, lowering the cost of design and making it easier to put electronic intelligence anywhere and everywhere. As hardware cost dropped, rising software costs became increasingly visible.

So, today, as costs climb, management puts everyone under increasing pressure to deliver projects on time and on budget. Yet, the cost of programming is still outpacing productivity. Software development and integration still lag the system hardware. The software crisis of the '80s rages on.

Tools for structured solutions

Once a problem grows beyond a certain point, the most efficient way to solve it is with a top down approach. You break the problem into units, program and debug each one, and combine the units into a unified solution.

That's the concept. But you can't stop there. In the '80s, bridging the gap between a conceptual solution and a working one will require tools as efficient as the top down method. New tools, like a CPU with a dramatically different architecture. An architecture uniquely suited to a world of higher level languages and structured programming. Tools like a modular operating system, of a kind never before available on a 16-bit microprocessor. Tools like the

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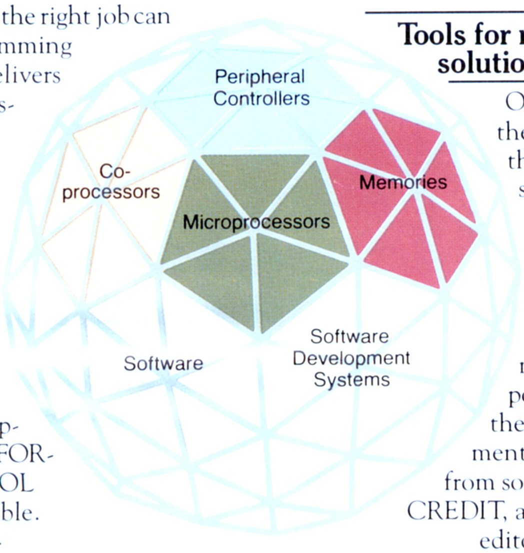

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Tools for realizing your solution

Of course, having the foundation and the concept of your solution doesn't help if you can't write the programs to implement it. So, Intel delivers development tools to support you through the entire development cycle. Support from source entry, with CREDIT, a CRT based text editor, through compiling and debugging, with an Intellec® development system and ICE™ hardware/software debugging system. Intel's tools work with you. They shorten development time and support the structured approach you've taken.

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Your first step toward productivity

How to get more information on solving the software crisis of the '80s.

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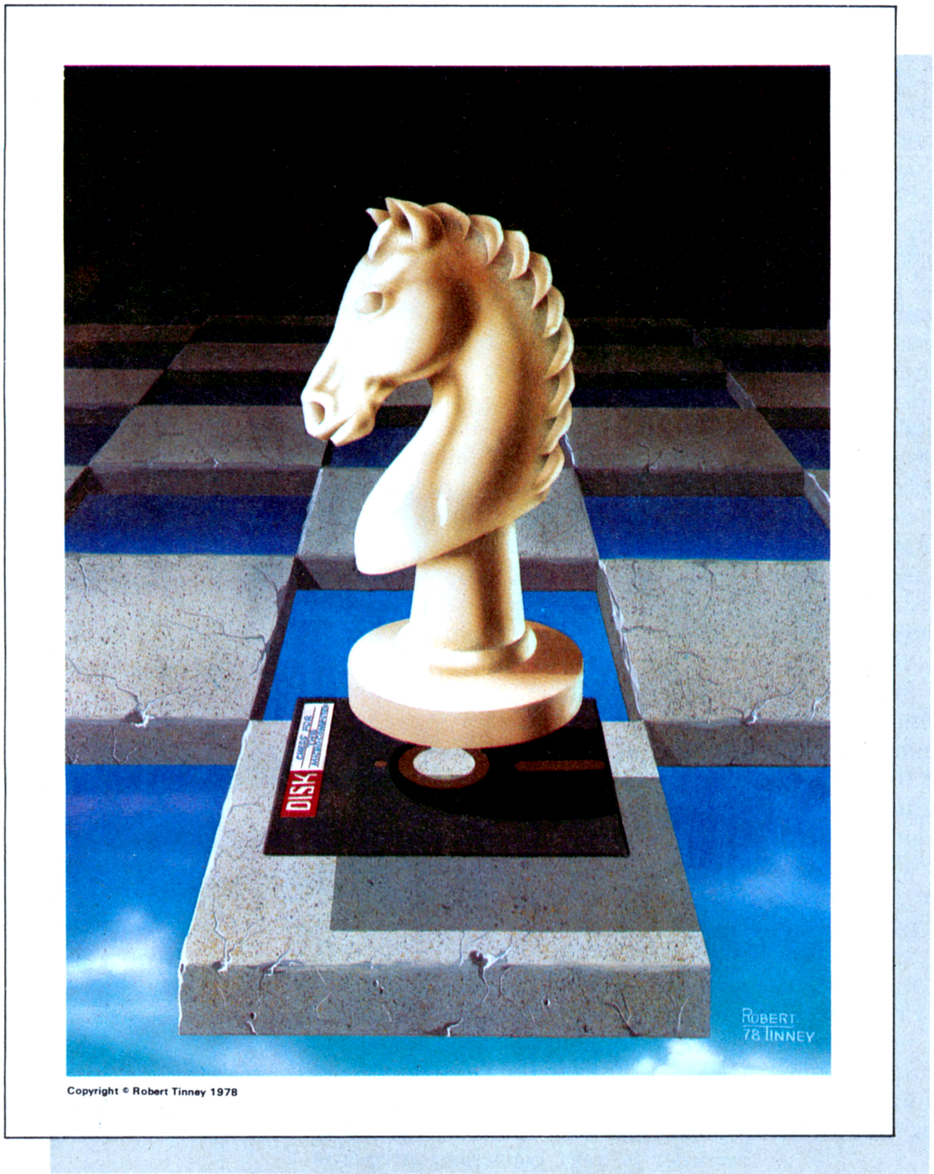

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Shack TRS-80. About two winters ago here at Cook Laboratories, we developed a modified tape format that records more reliably on the TRS-80. Without going into the details of the TRS-80 tape format, I can say that the unaltered tape signal crowds too much information into a given space and thus opens itself to reliability as well as saturation problems. The latter problem is what makes the TRS-80 normally so volume sensitive. The waveform we use at Cook Laboratories, when recording tapes for the TRS-80, reorders the waveform shape and narrows the pulse width so that the cassette interface does not get confused.

The various waveform modifications could certainly be used to improve the reliability of the cassette storage on other microcomputers. For example, on the old-model PETs, there is no way to alter the volume level of the built-in cassette recorder. However, Commodore can provide a documented program called S-21. This program, when running, monitors tape being played in the PET cassette deck and displays certain information about the quality of the tape signal on the PET screen. This is a very effective program to have if you know how to use it; Commodore is the only manufacturer I know that supplies a program like it.

Tape Is Also a Factor

Several factors having to do with the cassette tape itself can also affect the reliability of tape loading. As I mentioned before, a tape that is too thin will likely give in to tape weave. Tape stiffness is a property of the thickness of the backing and is proportional to the third power of the gauge thickness of the backing. This indicates that you should not use long-playing cassettes for program and data storage.

The thickness of the magnetic coating affects the reliability of cassette storage, but in a different way. Standard audio tapes, chromium dioxide or otherwise, are not optimal for digital recording because they are designed to give good frequency response in the low frequencies. But low frequencies are not needed here; rather, well-defined and sharp waveform transitions are what count. A thinner magnetic coating than what is used in standard audio cassettes results in nice improvements both in waveform resolution and sharpness of transition. Not incidentally, Cook Laboratories markets a custom line of digital cassettes under the trademark MICROFUSION. This tape has a thinner chromium dioxide coating and a heavier and, therefore, stiffer backing, both of which make it well suited for digital storage.

Cassette tapes can be used for reliable mass storage if the tape recorder is kept clean and properly aligned, if quality tape (especially tape made for digital storage) is used, and if the signal going from the cassette to the computer is monitored and kept constant (from tape to tape) with a peak-signal-strength meter. Although disks are readily available and bubble memories are not far away, no medium will ever become obsolete as long as it provides a needed function. Cassettes, too, are here to stay.■

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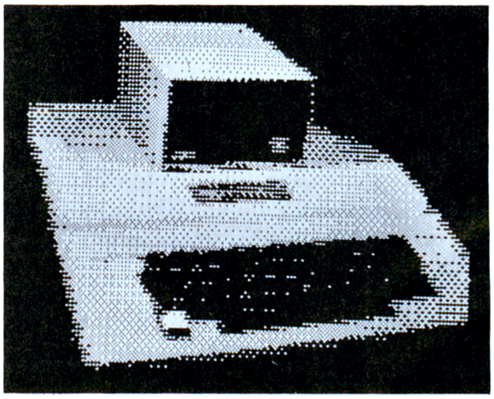

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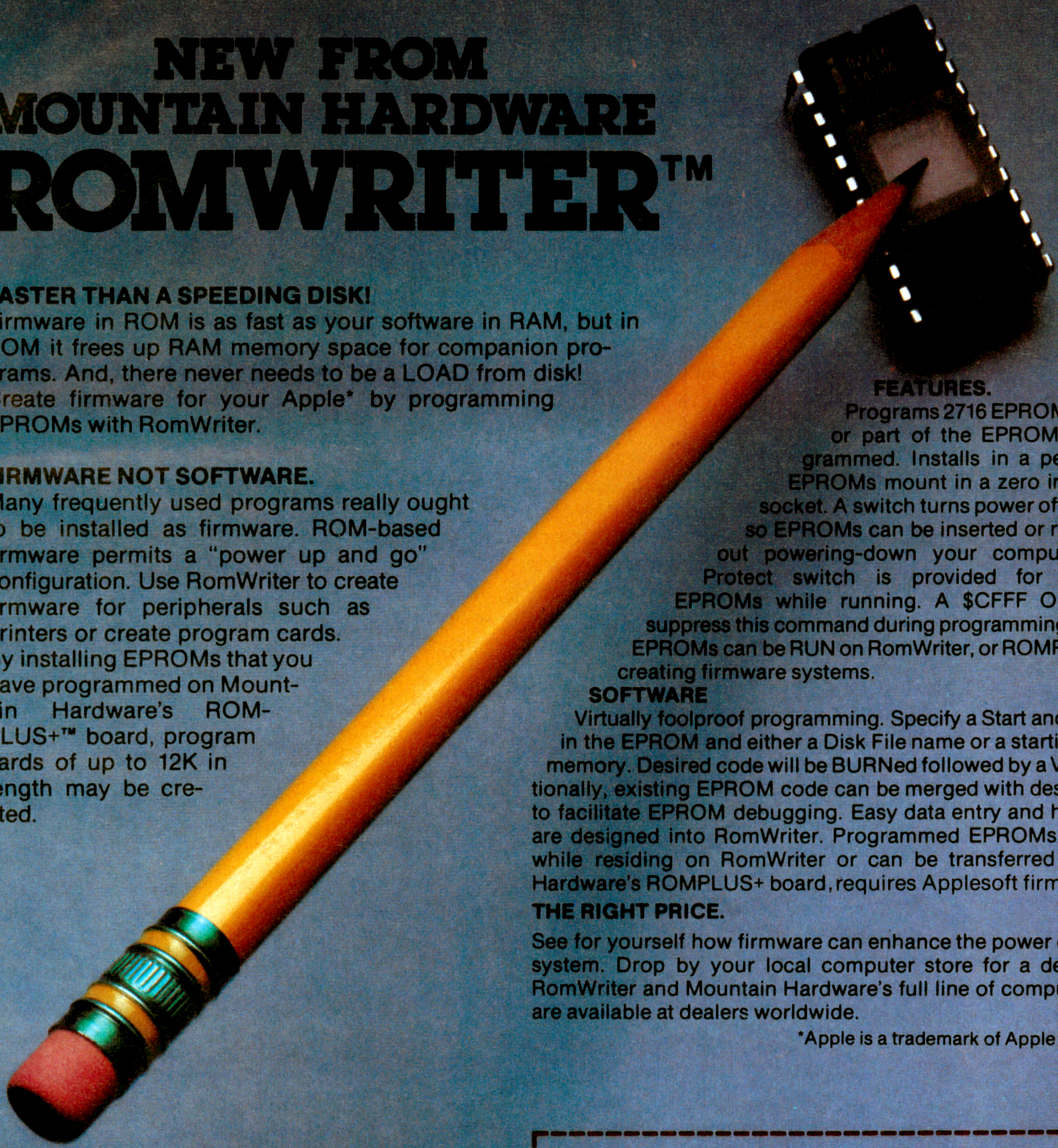

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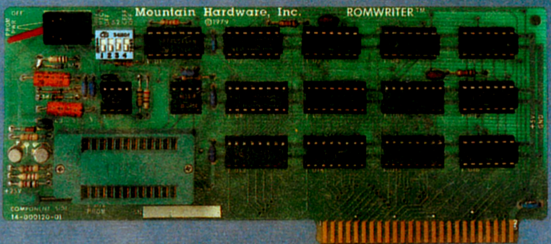

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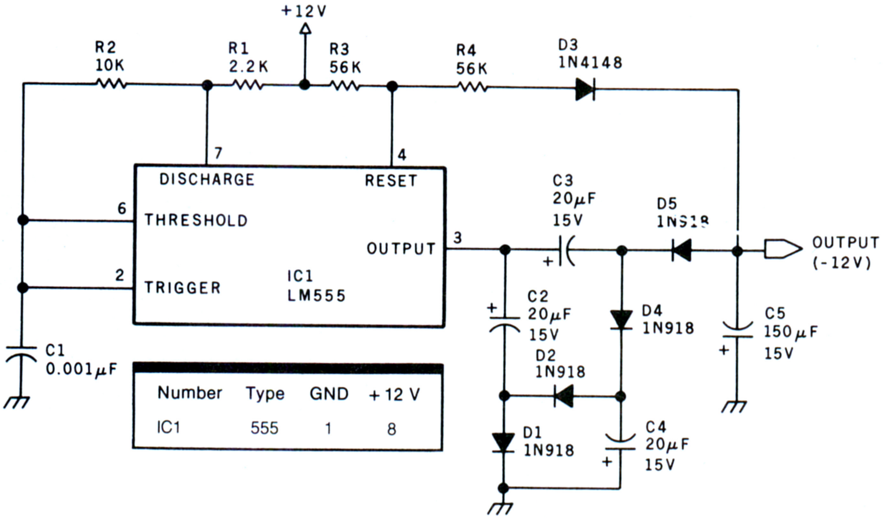
The heart of this circuit is a 555 timer that provides a drive signal of approximately 20 kHz to a voltage doubler. This signal is removed if the magnitude of the output voltage exceeds that of the supply voltage. In this sense, the converter operates as a switching-mode regulator.

The output voltage is set by controlling the timer via the reset input (ie: pin 4). When the output voltage reaches a negative potential with the same magnitude as the supply voltage, a low logic state is placed on the reset input, causing the timer output to go low and the increase in voltage magnitude to cease.■



Number	Type	GND	+12 V
IC1	555	1	8

Figure 1: *Schematic for the DC-to-DC converter. The 555 timer produces a rectangular wave at about 20 kHz, which is inverted by the diode-capacitor voltage-doubler arrangement. A feedback signal reaching the reset pin of the 555 regulates the magnitude of the output, which is −12 V at 25 mA.*

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I/O Expansion for the Radio Shack TRS-80

Part 1: Principles of Parallel Ports

Steve Ciarcia
POB 582
Glastonbury CT 06033

I receive a lot of mail: enough that I'm beginning to feel like the "Dear Abby" of the personal computer ranks. The sources of the letters range from high school students asking for advice on science fair projects to major corporations seeking consultant services. Even though it takes considerable time to answer this mail, I regard it as a significant opportunity to gauge reader interest. Every letter in some way contributes to my choice of article topics, either through suggestions or by continued occurrence of similar questions.

Recently, my mail has been dominated by owners of the Radio Shack TRS-80 Model I thirsting for hardware expansion by means other than Tandy Corporation equipment. The majority of questions concern connection of my interfaces to the TRS-80 expansion connector.

In general, I have tried to present projects that are computer independent. That is, the interfaces described are driven through parallel input/output (I/O) ports rather than directly from a computer bus. This had not been a problem in the past, because virtually all of the early personal computers incorporated some parallel I/O capability. For those experimenters interested in enhanced I/O capabilities, I presented the article "Memory-Mapped I/O" in the November 1977 BYTE on page 10 (reprinted in *Ciarcia's Circuit Cellar* Volume I, BYTE Books), which detailed parallel-port construction.

In the 2½ years since that article was first published, a number of significant changes have occurred in personal computing. Most importantly, the Radio Shack TRS-80, the Apple II and the Commodore PET were introduced. The difficulty in maintaining and operating a computer is no longer a serious consideration for most computer enthusiasts. Much of my mail indicates that a new explanation of parallel and serial I/O is in order, and that it is time for hardware-expansion circuits to be detailed.

> A *port* is a hardware channel for the computer to transmit and to receive *data* via an *external* peripheral device.

This month's Ciarcia's Circuit Cellar is the first of a two-part article on serial and parallel I/O port expansion of the TRS-80. The first part emphasizes parallel I/O, and the second part is concerned with serial interfacing. The result will be a complete Radio Shack software-compatible communications interface capable of supporting a variety of serial- and parallel-interfaced peripheral devices. The hardware was designed and the components were selected to be economical to build and easy to check out. First, here is a brief review of the basics.

What Is an I/O Port?

Just as some people are initially confused with the terms *hardware* and *software*, some find the concept of input and output ports difficult to understand without substantial explanation. The classical definition: a *port* is a hardware channel for the computer to transmit and receive *data* via an *external* peripheral device. The key words in this definition are *external* and *data* which imply externally collected information; the channel through which this data is obtained is called a *port*. A printer is a typical external peripheral device. The characters to be printed are sent from the computer to the printer. In some of the more sophisticated units, status signals such as *busy* and *out of paper* are returned to the computer from the printer.

Ports can be either parallel or serial. In *parallel* mode, data is transferred in increments equivalent to the word size of the computer. On the Z80, for instance, an 8-bit microprocessor, an output instruction through a parallel port transfers 8 bits at a time. A 16-bit processor such as the Intel 8086 transfers data in 16-bit increments. The number of bits transmitted simultaneously by a parallel port is dependent upon the size of the microprocessor data bus and how many bits the processor can transfer simultaneously.

However, serial data is always transmitted a single bit at a time, according to a fixed schedule defined by the data rate (usually expressed in bits per second, or *bps*) and a few specific options. The microprocessor has no single instruction that transmits serial data. It must rely on another device called a universal asynchronous receiver/transmitter (UART) to put the data word into serial form and transmit it. Any communication between the processor and the UART is in parallel form and is done through the processor's memory reference or I/O data-transfer instructions. A more in-depth discussion of serial ports will be presented next month in Part 2.

Address, Data, and Control Buses

Consider a computer system that includes a printer, video terminal with keyboard, and an audio cassette recorder as peripherals. Data would have to be relayed to the printer, to and from the video terminal, and to and from the cassette recorder. How can the computer tell the difference between data destined for the terminal and the data destined for the printer?

Most microprocessors incorporate a bidirectional *data bus* and an *address bus*: this is shown in figure 1. To keep track of the data transfer between the processor and its peripherals, the system uses a quantity of control signals which together can be called the *control bus*. The usual 8-bit processor has an 8-bit data bus, a 16-bit address bus, and a dozen or so control signals.

When the microprocessor is reading a data byte from memory, the address of the memory location being referenced is placed on the address bus. Memory information stored at that location goes on the data bus and flows from memory to the processor. When data is being written into memory, the operation is reversed. A 16-bit address bus allows the processor to directly address 65,532 (ie: 64 K) memory locations.

In an 8080 or Z80 processor there is a specific set of instructions that perform input/output functions. The operation of these I/O instructions is similar to that of memory-reference instructions, except that only 8 bits of the address bus are used. These 8 bits

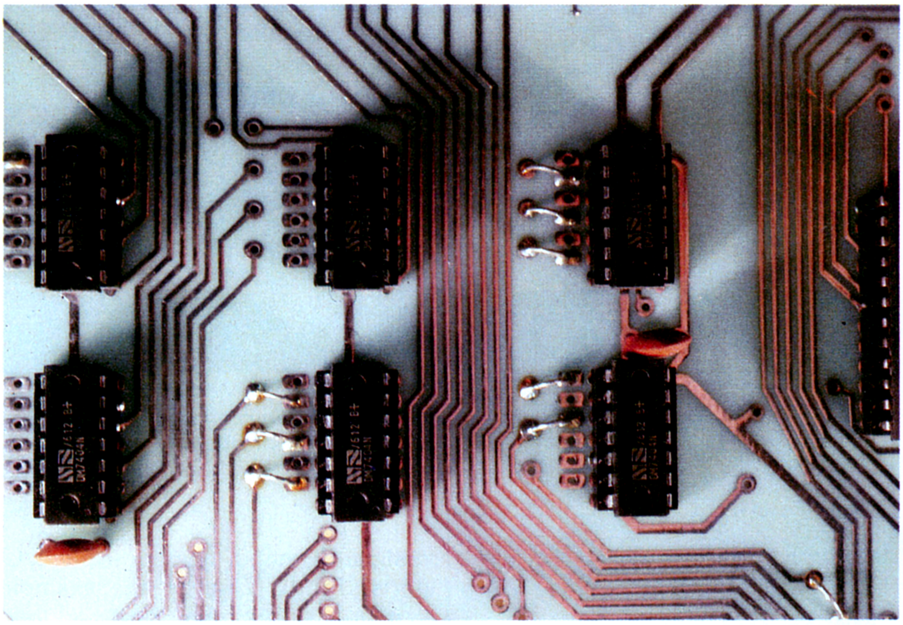

Photo 1: *There are a variety of ways to decode the address for a particular input/output (I/O) port from the signals present on the address bus. The least expensive method uses inverters and printed-circuit-board jumpers to select the correct logic polarities. Three address lines are connected through each 7404 hex inverter with two possible connections for each address line. A connection to the upper trace on the circuit board decodes a logic 1; a connection to the lower trace decodes a logic 0.*

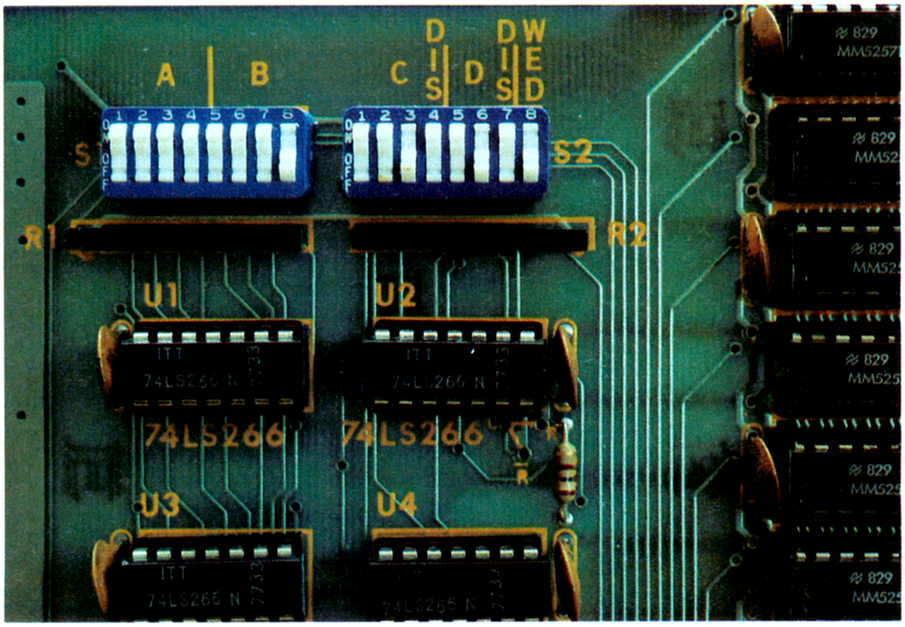

Photo 2: *A more expensive and more easily changed addressing scheme employs dual-in-line-pin (DIP) switches and exclusive-NOR gates. The schematic diagram for this is shown in figure 3b.*

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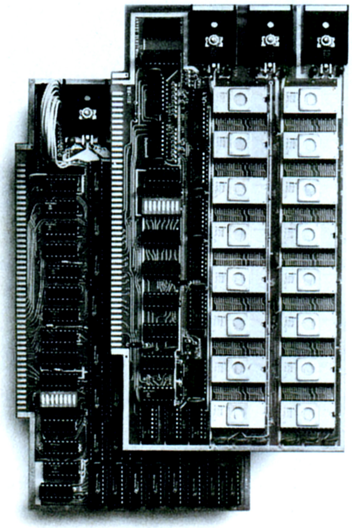

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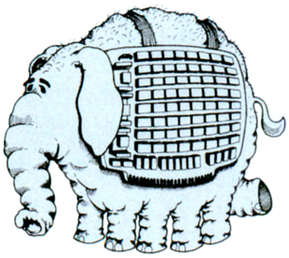

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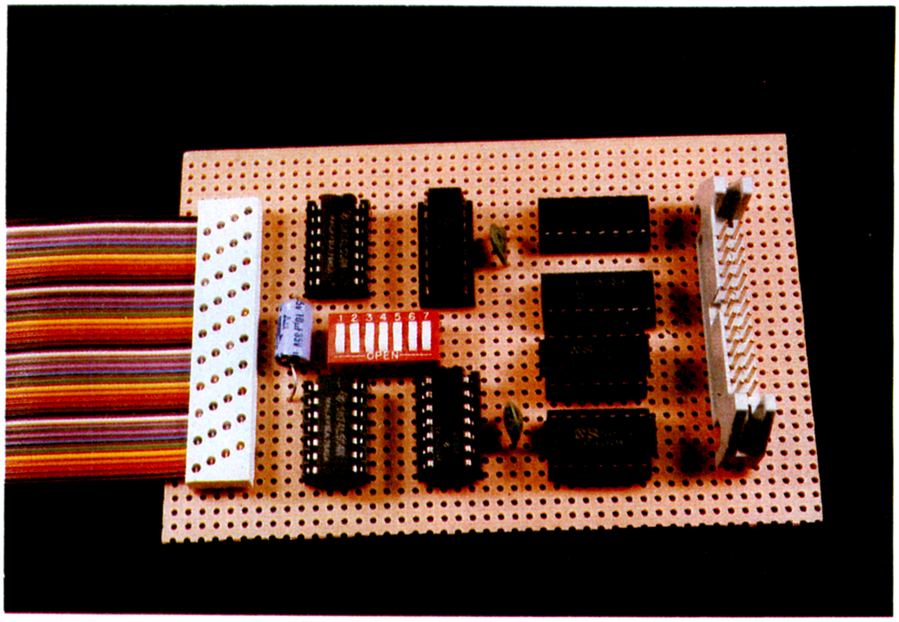

Photo 3: *Prototype of an 8-bit I/O port for the Radio Shack TRS-80. The ribbon cable at left connects to the expansion port on the keyboard/processor unit. The two I/O ports are brought out to the ribbon-cable connector on the right edge of the board.*

designate one of 256 possible I/O ports. In the case of the example system, a separate port address would be used for each peripheral.

Keeping track of bus direction and information flow is a matter of properly decoding the control signals during program execution. In a Z80 for instance, any memory-reference operation is signified by the control signal $\overline{MREQ}$ in the processor going to a logic 0, or low, state. An input or output operation is designated by the $\overline{I/OREQ}$ control signal being at logic 0.

The direction of the data bus depends on whether the processor is trying to read or to write data. If the processor is in a read mode, the $\overline{RD}$ control signal becomes a logic 0; if the processor is writing, the $\overline{WR}$ line is in the 0 state. Monitoring these four lines, $\overline{MREQ}$, $\overline{I/OREQ}$, $\overline{RD}$, and $\overline{WR}$, gives us all the information necessary to support I/O decoding functions. Figure 2 demonstrates how these control outputs are combined for system use.

Address Decoding

So far we have discussed how to determine when the processor wants to send a character to an output device. In such an operation the $\overline{I/OREQ}$ and $\overline{WR}$ lines are both low. To tell the difference between data for the printer and data for the terminal, we must decode the 8-bit port address.

The port address is determined by the logic voltages present on the low-order eight lines (that is, the 8 least significant bits) of the address bus during I/O operations. Various techniques can be employed to decode these lines. Figure 3 outlines a few simple methods. The objective, whatever the logic employed, is to produce a single pulse (ie: a strobe) whenever the logic states representing a particular address appear on the address bus. To eliminate false outputs when the processor is executing instructions not dealing with I/O, it is best to combine control and address signals as demonstrated in figure 4.

If you own a 6800- or 6502-based system, you have probably noticed that the processor has no special I/O instructions. This does not mean that these processors have no external communications capability, only that these processors communicate with peripheral devices differently. How can we discover this different method? Let us begin by looking closely at the I/O functions of the 8080 and Z80 that we have just discussed.

A close inspection of the I/O functions of an 8080 or Z80 should point

Text continued on page 30

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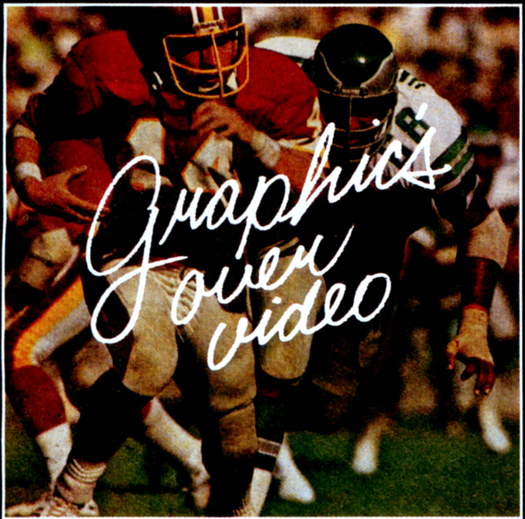

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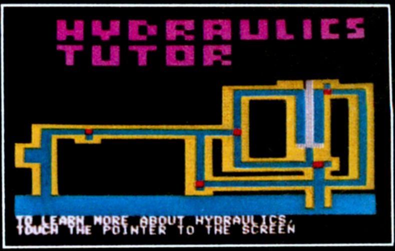

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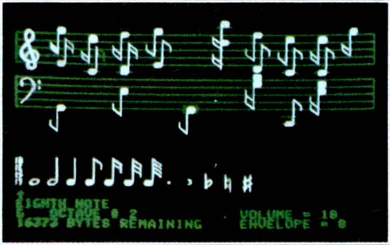

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EIGHTH NOTE
   OCTAVE = 2
16373 BYTES REMAINING        VOLUME = 10
                             ENVELOPE = 0
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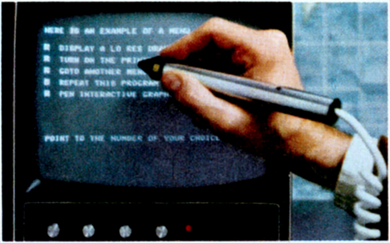

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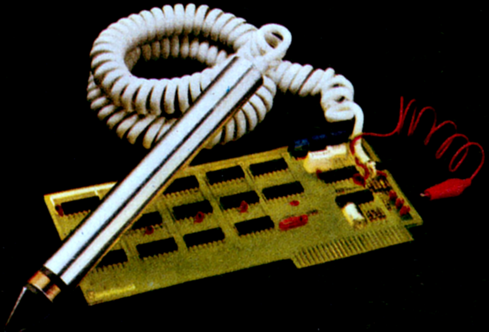

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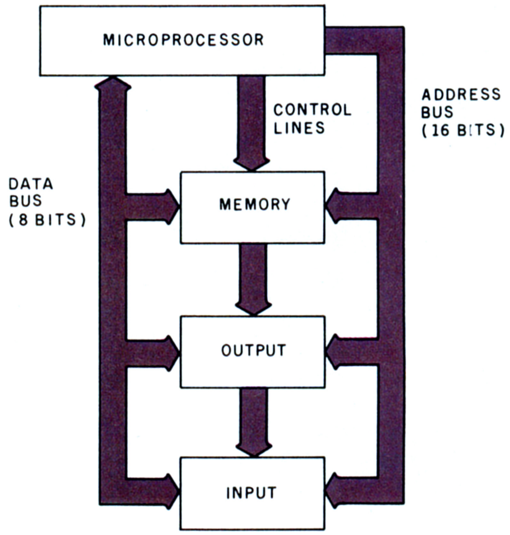

Figure 1: *Block diagram of a microcomputer system that uses an 8-bit microprocessor such as the Z80. This system uses bussing techniques that are both multiplexed and bidirectional.*

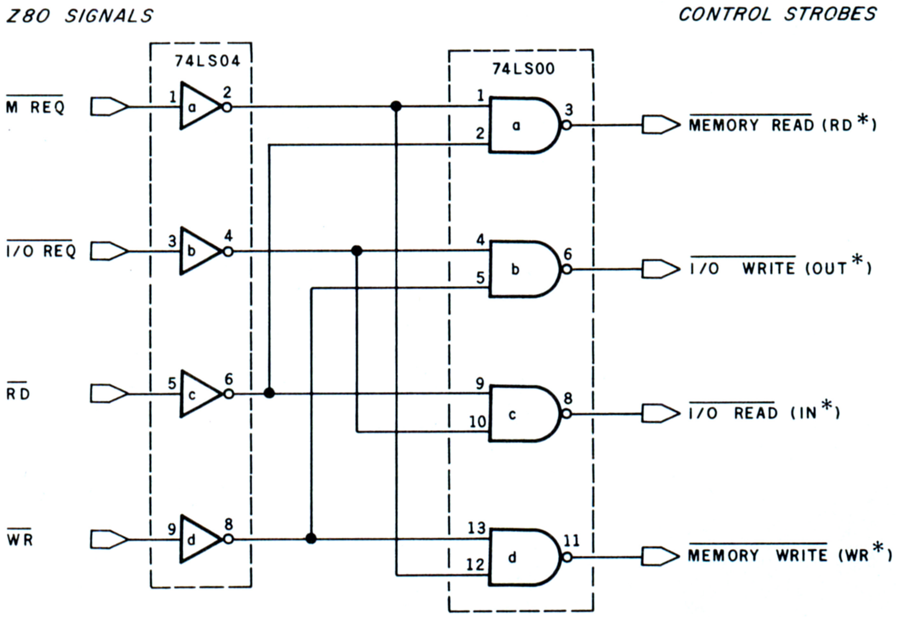

Figure 2: *Control signals on the Z80 microprocessor. The Z80 uses a variety of control signals to keep data flowing at the right time and in the right direction. Four control signals are as follows: the $\overline{MREQ}$ line goes to a low state (ie: a logic 0) when a memory-reference operation is in progress; the $\overline{I/OREQ}$ line goes to a low state when an input/output (I/O) operation is in progress; the $\overline{RD}$ line goes low when the processor is reading data from memory or from a peripheral device; the $\overline{WR}$ line goes low when the processor is writing data to memory or to a peripheral device. The $\overline{RD}$ and $\overline{WR}$ signals control the direction that data flows along the bidirectional data bus. Monitoring these four lines gives us all the information necessary to support I/O decoding functions.*

Signals from the four processor control lines are logically combined to form control-strobe signals that perform specific functions. The characters in parentheses give the names by which the control-strobe signals are known in the documentation for the Radio Shack TRS-80.

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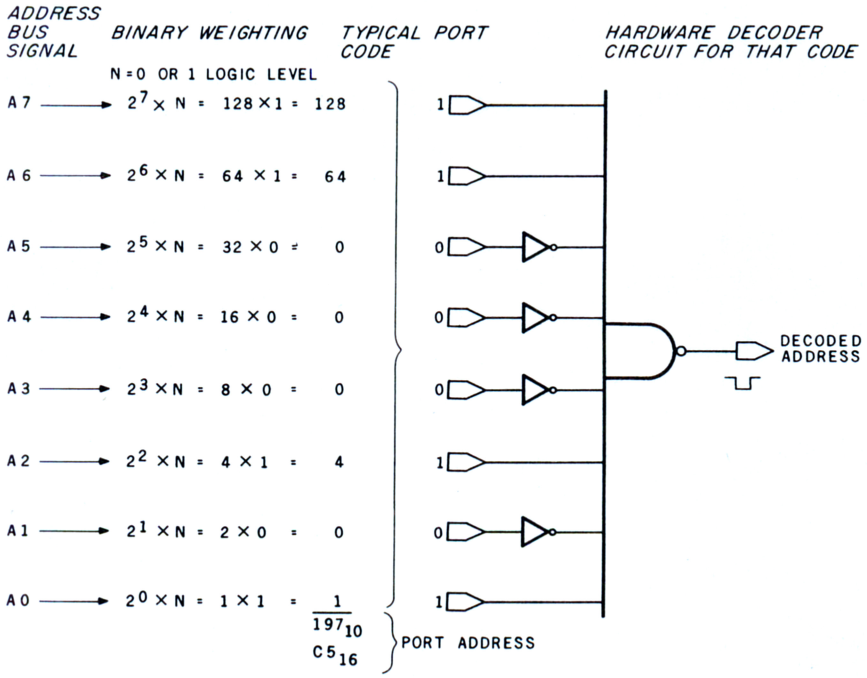
ADDRESS BUS SIGNAL
BINARY WEIGHTING
TYPICAL PORT CODE
HARDWARE DECODER CIRCUIT FOR THAT CODE
N=0 OR 1 LOGIC LEVEL
A7 → $2^7 \times N = 128 \times 1 = 128$
A6 → $2^6 \times N = 64 \times 1 = 64$
A5 → $2^5 \times N = 32 \times 0 = 0$
A4 → $2^4 \times N = 16 \times 0 = 0$
A3 → $2^3 \times N = 8 \times 0 = 0$
A2 → $2^2 \times N = 4 \times 1 = 4$
A1 → $2^1 \times N = 2 \times 0 = 0$
A0 → $2^0 \times N = 1 \times 1 = 1$
197_{10}
$C5_{16}$
PORT ADDRESS
1
1
0
0
0
1
0
1
DECODED ADDRESS

Figure 3a: *Various methods can be employed to decode the address signals that appear on the address bus during I/O operations. Here, various inverters and an eight-input NAND gate are hardwired in a configuration that will produce a logic 0 output for one of 256 possible I/O port addresses. The logic 0 output can be used to activate the interface for the peripheral device. Here the circuit decodes the address hexadecimal C5, or decimal 197.*

Number	Type	+5 V	GND
IC1	74LS85	16	8
IC2	74LS85	16	8
IC3	74LS04	14	7

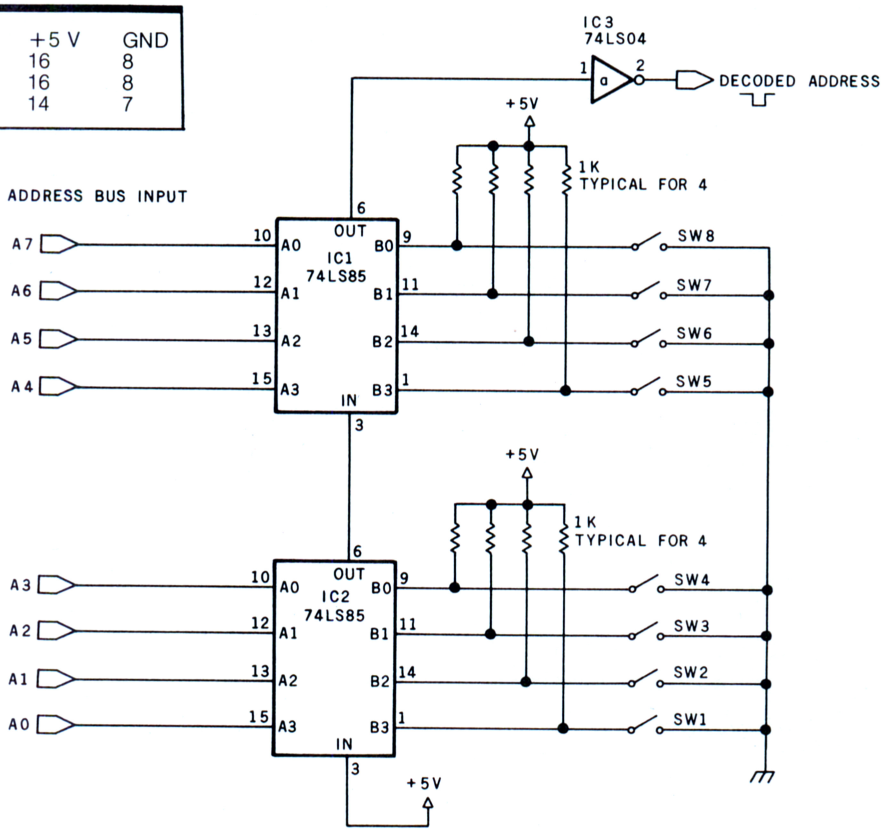
IC3
74LS04
1
a
2
DECODED ADDRESS
+5V
1K
TYPICAL FOR 4
ADDRESS BUS INPUT
A7
A6
A5
A4
10
12
13
15
A0
A1
A2
A3
6
OUT
IC1
74LS85
B0
B1
B2
B3
IN
9
11
14
1
3
SW8
SW7
SW6
SW5
+5V
1K
TYPICAL FOR 4
A3
A2
A1
A0
6
OUT
IC2
74LS85
IN
3
+5V
SW4
SW3
SW2
SW1

Figure 3b: *Another method of decoding an address signal. Two 4-bit comparators can be cascaded together to decode an 8-bit address. The desired 8-bit port address is set up on switches SW8 thru SW1. When the combination of high and low logic states that corresponds to the desired address appears on the address bus, the output signal produced at pin 2 of IC3 (the 74LS04 inverter) will go low to a logic 0 state. This decoding method allows the port addresses to be easily changed, but the method here is considerably more expensive than the decoding method shown in figure 3a. The switches are single-pole, single-throw (SPST) types; an open switch shows logic 1, and a closed switch shows logic 0.*

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Text continued from page 24:

out that the I/O instructions bear a surprising resemblance to memory-reference instructions. The 6800 and 6502 microprocessors actually allocate a certain portion of their memory address space to be decoded and to function as I/O ports.

This technique, which can be used on the Z80 and 8080 just as easily, has certain advantages in speed and ease of use over direct I/O instructions. This technique is referred to as *memory-mapped I/O*. An illustration of the logic associated with this method is in figure 5. For a more rigorous analysis of memory-mapped I/O, I refer you to the November 1977 "Ciarcia's Circuit Cellar" article previously mentioned.

The final area for consideration is the actual transfer of data to and from the bidirectional data bus. The circuits of figure 4 and figure 5 tell only *when* the I/O operation occurs. Additional logic has to be provided to place data on the bus during an input instruction or to latch and hold the contents of the data bus during output instructions.

Number	Type	+5 V	GND
IC1	74LS266	14	7
IC2	74LS266	14	7
IC3	74LS30	14	7

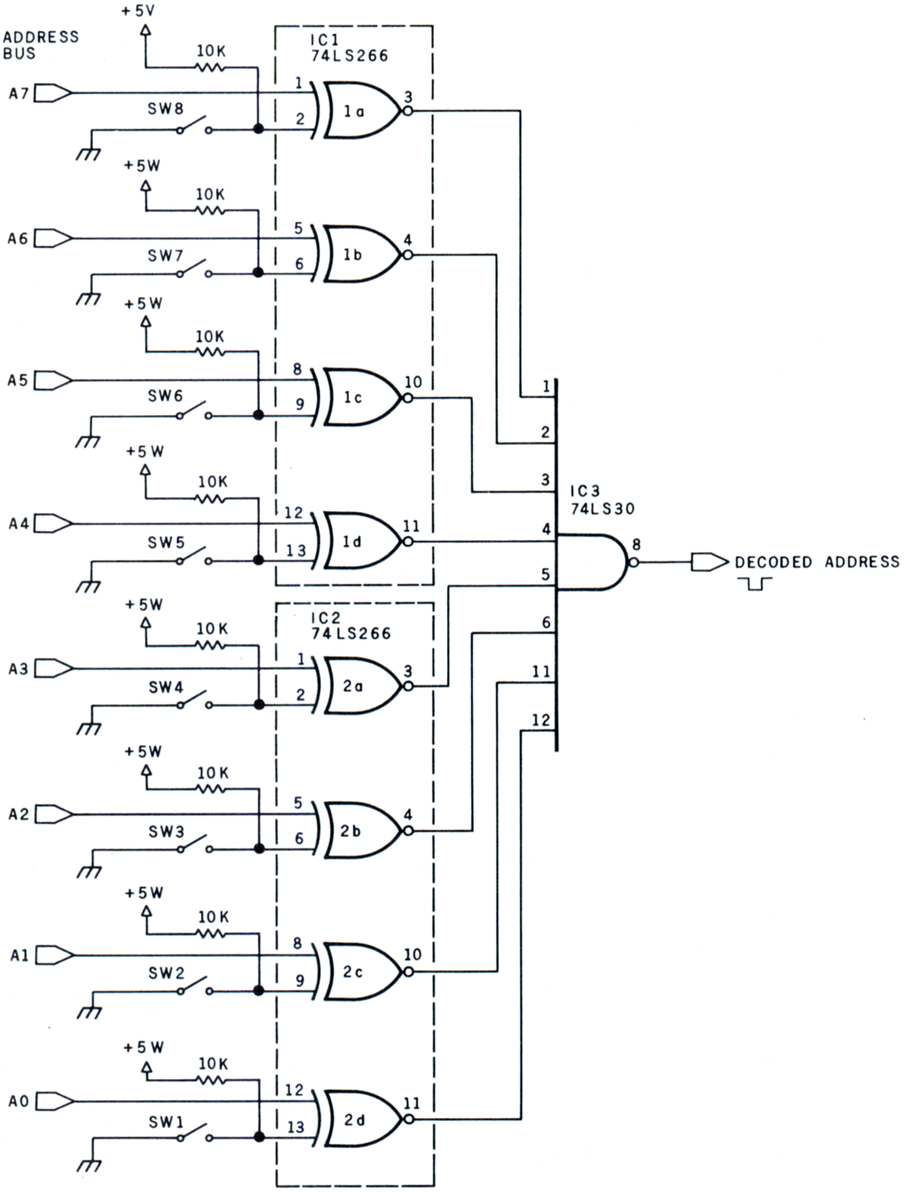

Figure 3c: *Another method of decoding an 8-bit address, using exclusive-NOR gates and an eight-input NAND gate. As in figure 3b, the desired port address is set up on switches SW8 thru SW1.*

When the 8080 or Z80 assembly language instruction OUT (*N*),D is executed, the contents of the accumulator, D, are placed on the data bus and written into device *N*. The same is true for the BASIC-language instruction OUT *N*,D. The data is actually valid during only a few clock cycles, perhaps 500 ns. Making this data available for longer periods of time requires the addition of an 8-bit *latch*: the latch is made from a set of clocked flip-flops.

The output lines are attached to the data bus. When the proper output instruction is executed, signified by a strobe signal from our address and $\overline{\text{I/O WRITE}}$ decoder circuit as shown in figure 6, the contents of the data bus are transferred into the 8-bit register in synchronization with the processor clock signal. This combination of circuitry is commonly called an *8-bit latched parallel output port*.

External devices cannot be directly connected to the data bus for input, because of the possibility that interference and bus-loading problems will result. A three-state buffer is used as a *gate* to allow signals from the peripheral device to be placed onto the bus at the appropriate time.

During an input operation the process used for output is reversed. When the proper input sequence is executed, signified by the appropriate output from the address decoder and $\overline{\text{I/O READ}}$ decoder, the 8-bit three-state buffer is strobed into operation during the few clock cycles it takes for the processor to execute the input instruction. Logic levels present on the buffer input lines during that instant become impressed onto the data bus and are transferred into the accumulator. Figure 6 shows the logic elements that perform these functions.

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Text continued on page 38

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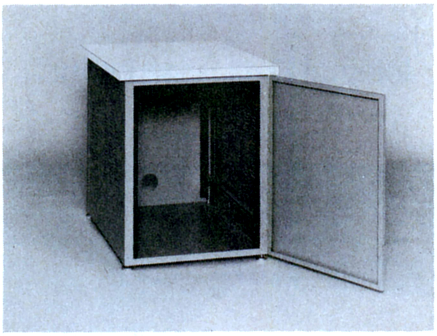

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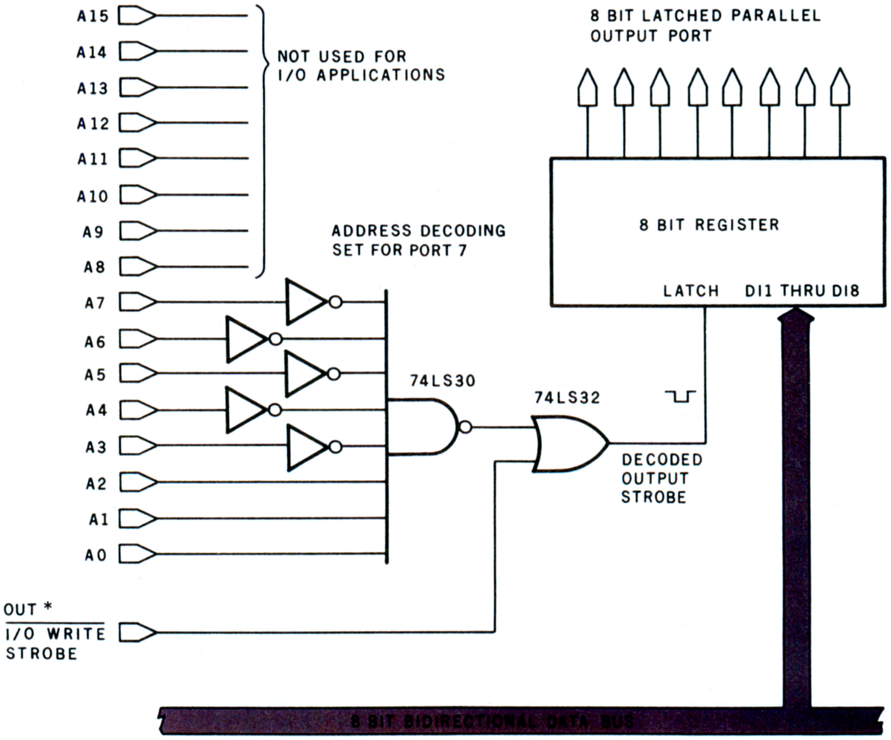
A15
A14
A13
A12
A11
A10
A9
A8
NOT USED FOR I/O APPLICATIONS
A7
A6
A5
A4
A3
A2
A1
A0
ADDRESS DECODING SET FOR PORT 7
74LS30
74LS32
OUT *
I/O WRITE STROBE
DECODED OUTPUT STROBE
8 BIT LATCHED PARALLEL OUTPUT PORT
8 BIT REGISTER
LATCH
DI1 THRU DI8
8 BIT BIDIRECTIONAL DATA BUS

Figure 4a: *Block diagram of a typical parallel output port. The logic that decodes the 8-bit port address was shown in three forms in figure 3. The signal from the address-decoding circuit is logically combined with one of the control signals from figure 2 (I/O WRITE) to produce an output strobe signal that activates the 8-bit output latch register.*

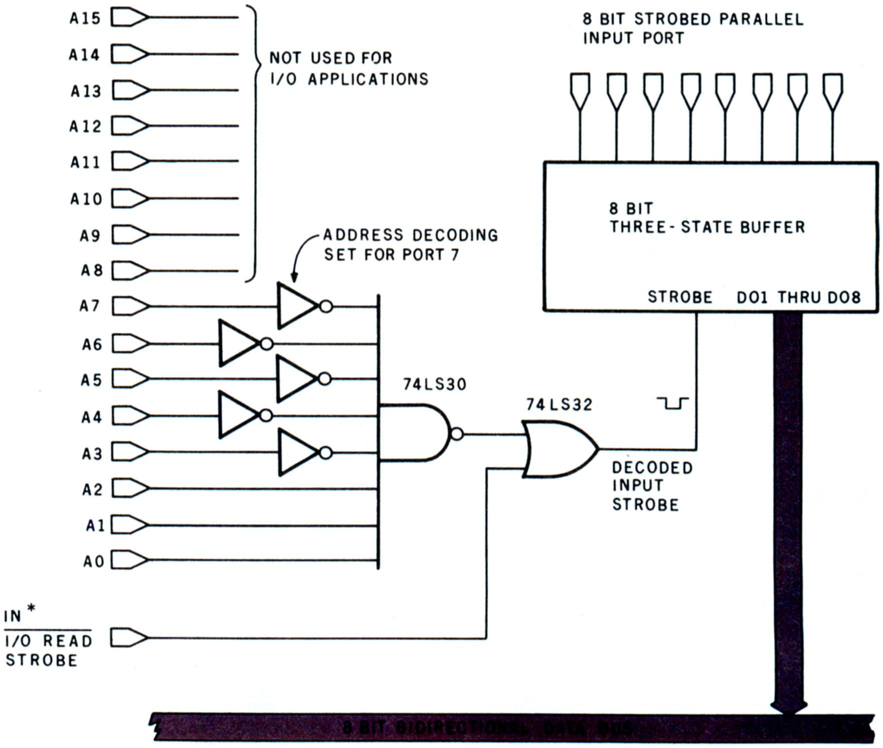
A15
A14
A13
A12
A11
A10
A9
A8
NOT USED FOR I/O APPLICATIONS
A7
A6
A5
A4
A3
A2
A1
A0
ADDRESS DECODING SET FOR PORT 7
74LS30
74LS32
IN *
I/O READ STROBE
DECODED INPUT STROBE
8 BIT STROBED PARALLEL INPUT PORT
8 BIT THREE-STATE BUFFER
STROBE
DO1 THRU DO8
8 BIT BIDIRECTIONAL DATA BUS

Figure 4b: *Block diagram of a typical parallel input port. Note the resemblance to the output port of figure 4a.*

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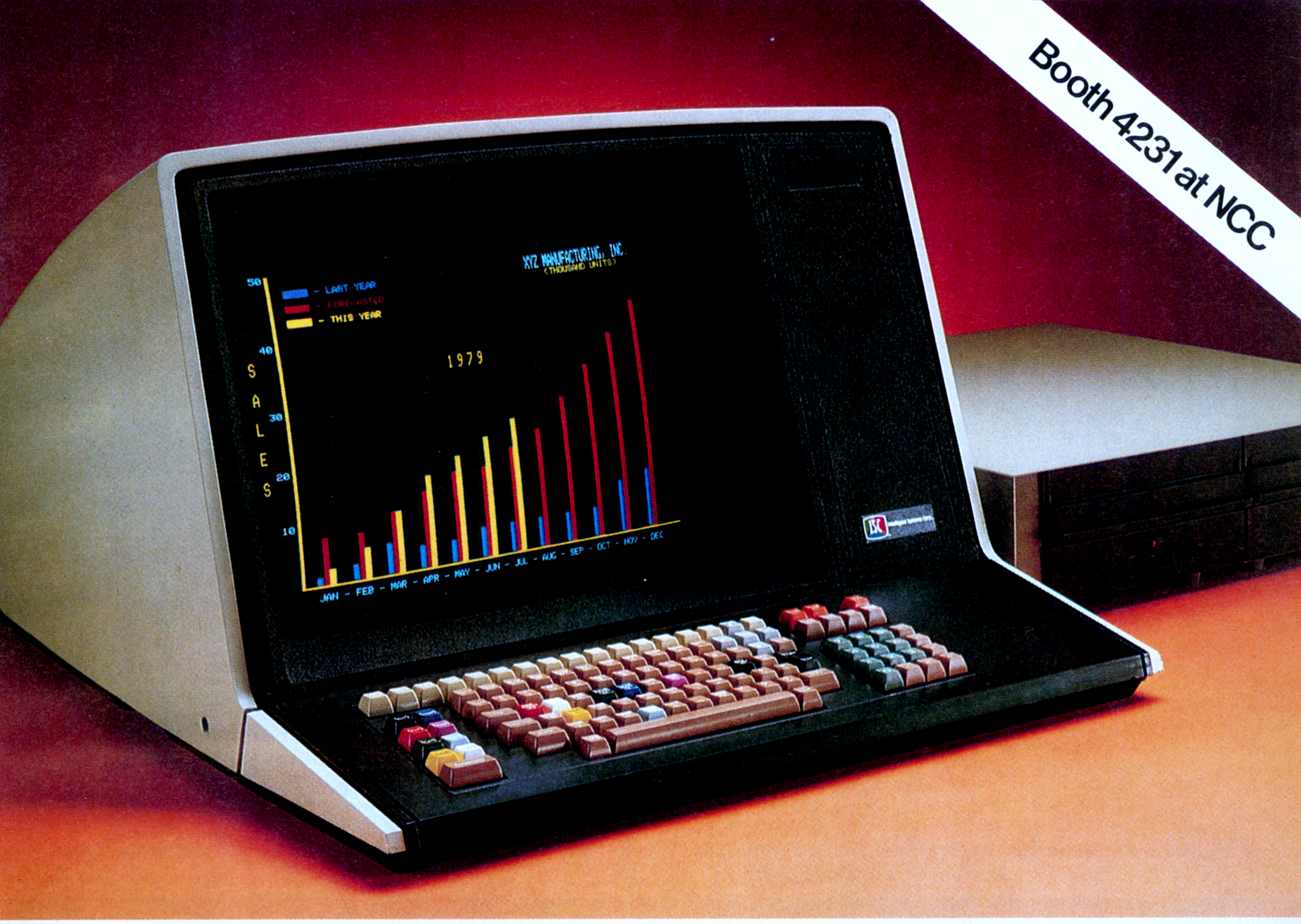

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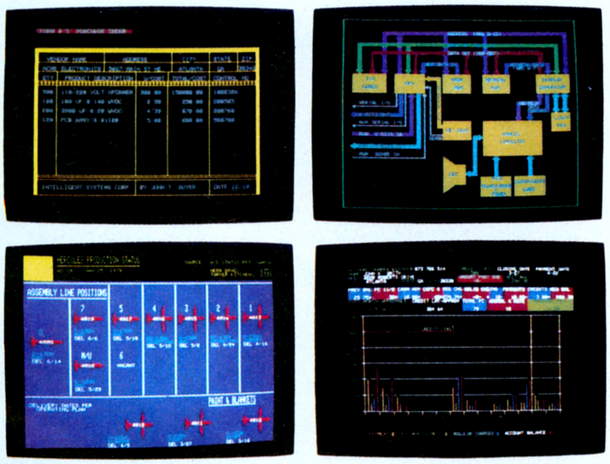

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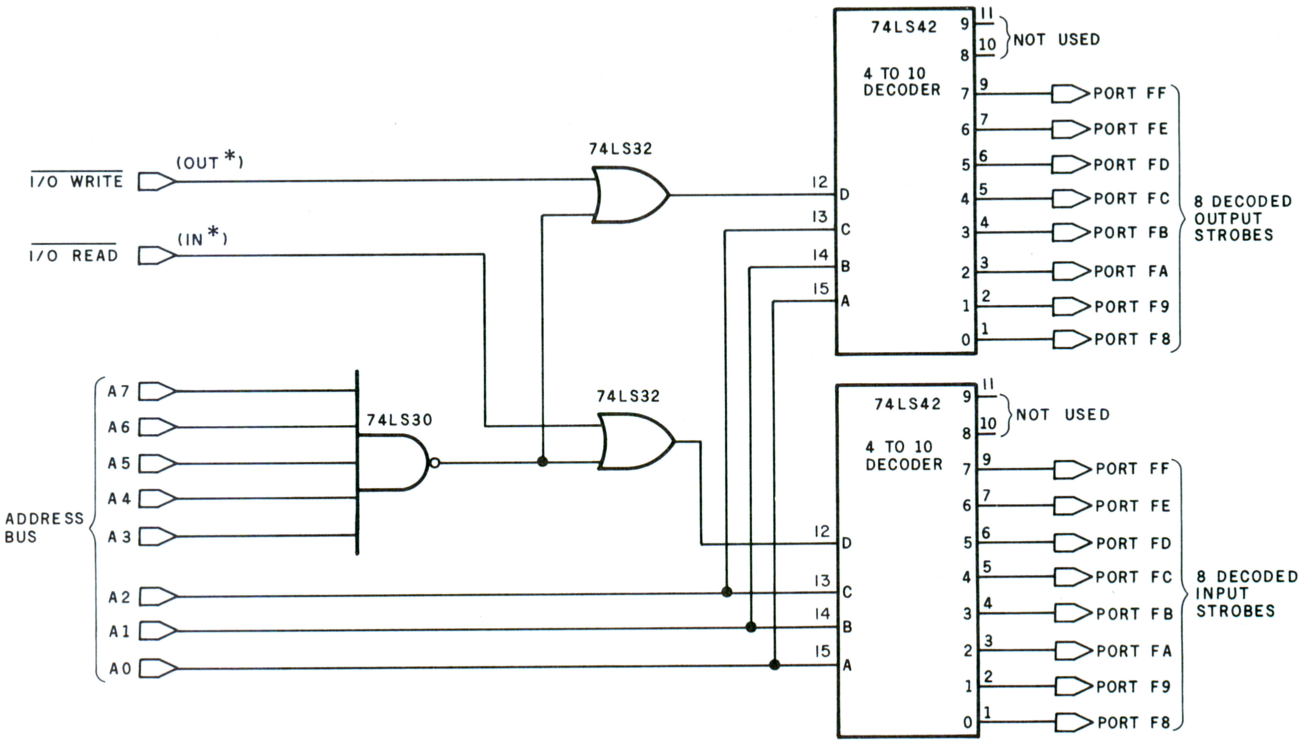
I/O WRITE
(OUT*)
I/O READ
(IN*)
74LS32
74LS32
74LS30
ADDRESS BUS
A7
A6
A5
A4
A3
A2
A1
A0
74LS42
4 TO 10 DECODER
NOT USED
PORT FF
PORT FE
PORT FD
PORT FC
PORT FB
PORT FA
PORT F9
PORT F8
8 DECODED OUTPUT STROBES
8 DECODED INPUT STROBES
12
13
14
15
D
C
B
A
9
8
7
6
5
4
3
2
1
0
11
10

Figure 4c: *Schematic diagram of a circuit that produces eight decoded input-strobe signals and eight decoded output-strobe signals. The port addresses produced are hexadecimal F8 thru FF.*

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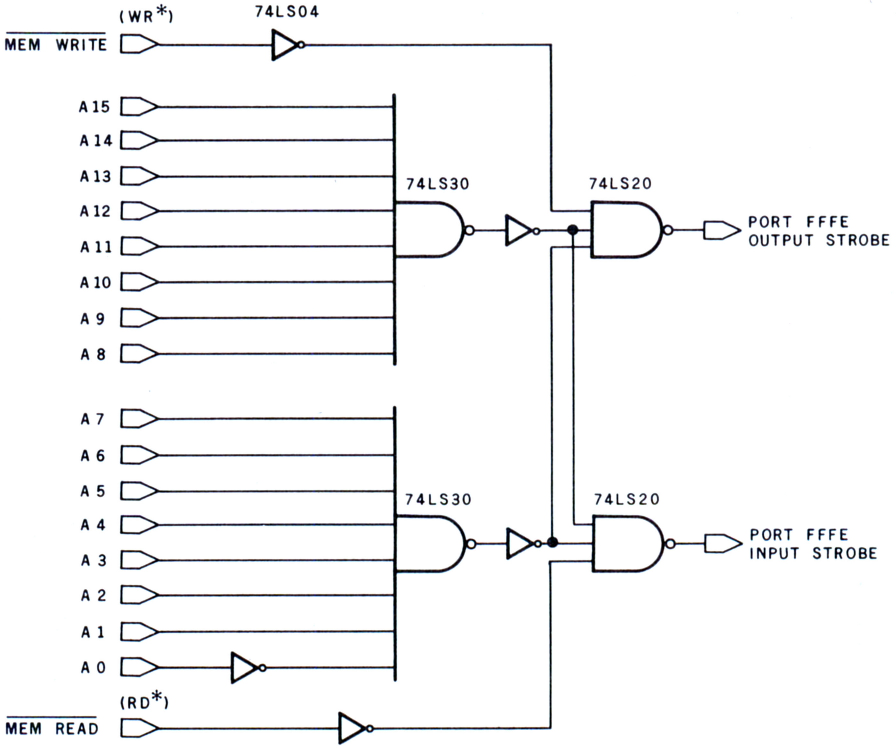
(WR*)
MEM WRITE
74LS04
A15
A14
A13
A12
A11
A10
A9
A8
74LS30
74LS20
PORT FFFE OUTPUT STROBE
A7
A6
A5
A4
A3
A2
A1
A0
74LS30
74LS20
PORT FFFE INPUT STROBE
(RD*)
MEM READ

Figure 5: *Memory-mapped input and output. Some microprocessors do not have specific input and output instructions. In systems that use such microprocessors, the I/O port hardware is wired as a memory location; I/O operations take place using the memory-reference instructions (eg: load-into-accumulator and store-in-memory instructions) of the microprocessor. This type of addressing is called memory-mapped I/O, and all sixteen lines on the address bus must be decoded to perform an I/O operation.*

Number	Type	+5 V	GND
IC1	74LS377	20	10
IC2	74LS244	20	10
IC3	7404	14	7

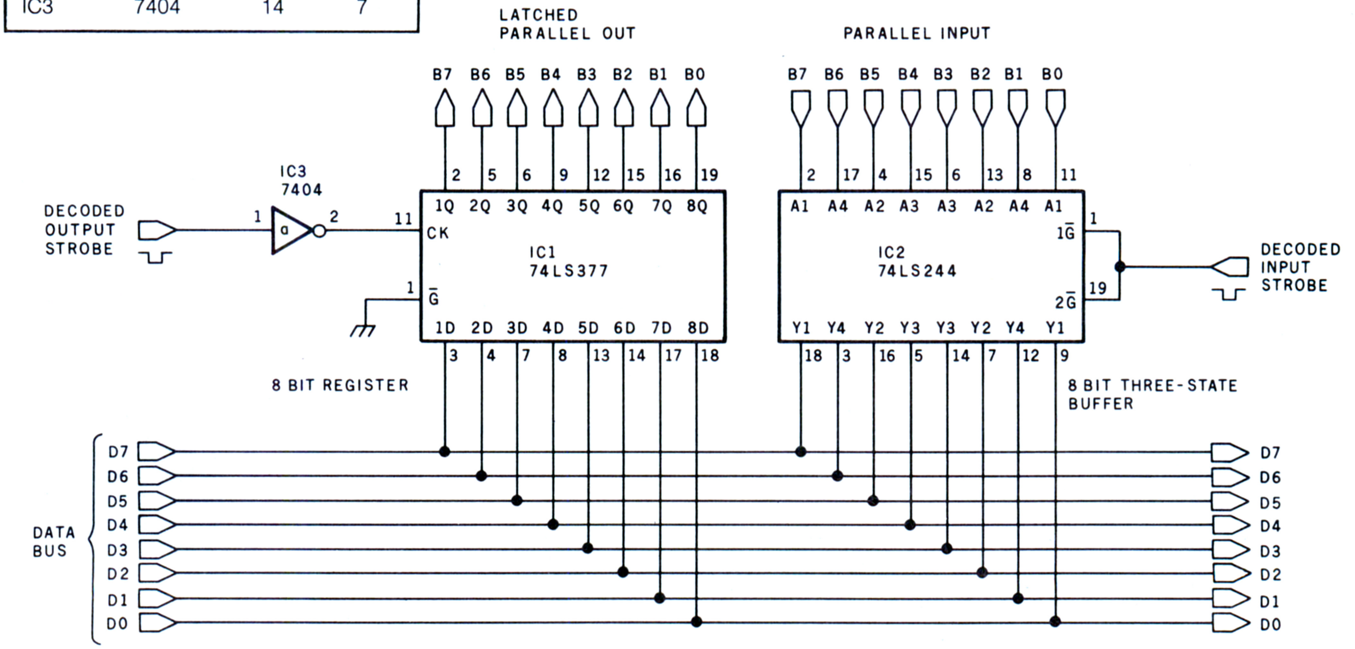
LATCHED PARALLEL OUT
PARALLEL INPUT
B7 B6 B5 B4 B3 B2 B1 B0
B7 B6 B5 B4 B3 B2 B1 B0
IC3 7404
DECODED OUTPUT STROBE
CK
G̅
IC1 74LS377
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q
1D 2D 3D 4D 5D 6D 7D 8D
IC2 74LS244
A1 A4 A2 A3 A3 A2 A4 A1
Y1 Y4 Y2 Y3 Y3 Y2 Y4 Y1
1G̅
2G̅
DECODED INPUT STROBE
8 BIT REGISTER
8 BIT THREE-STATE BUFFER
DATA BUS
D7 D6 D5 D4 D3 D2 D1 D0

Figure 6: *Data connections in input and output ports. Once the proper port address has been decoded and combined with the read- or write-control signal to form an I/O strobe signal, the actual process of accessing the data bus for data transfer is relatively easy.*

For input to the accumulator (the most common pathway for I/O), a three-state buffer is used in conjunction with the decoded input-strobe signal that controls the enable line of the buffer.

For output from the accumulator, an 8-bit latch is connected to the data bus. During the execution of the output instruction, the contents of the data bus are clocked into the latch register and are latched there by the output-strobe signal.

Circle 20 on inquiry card. ➡

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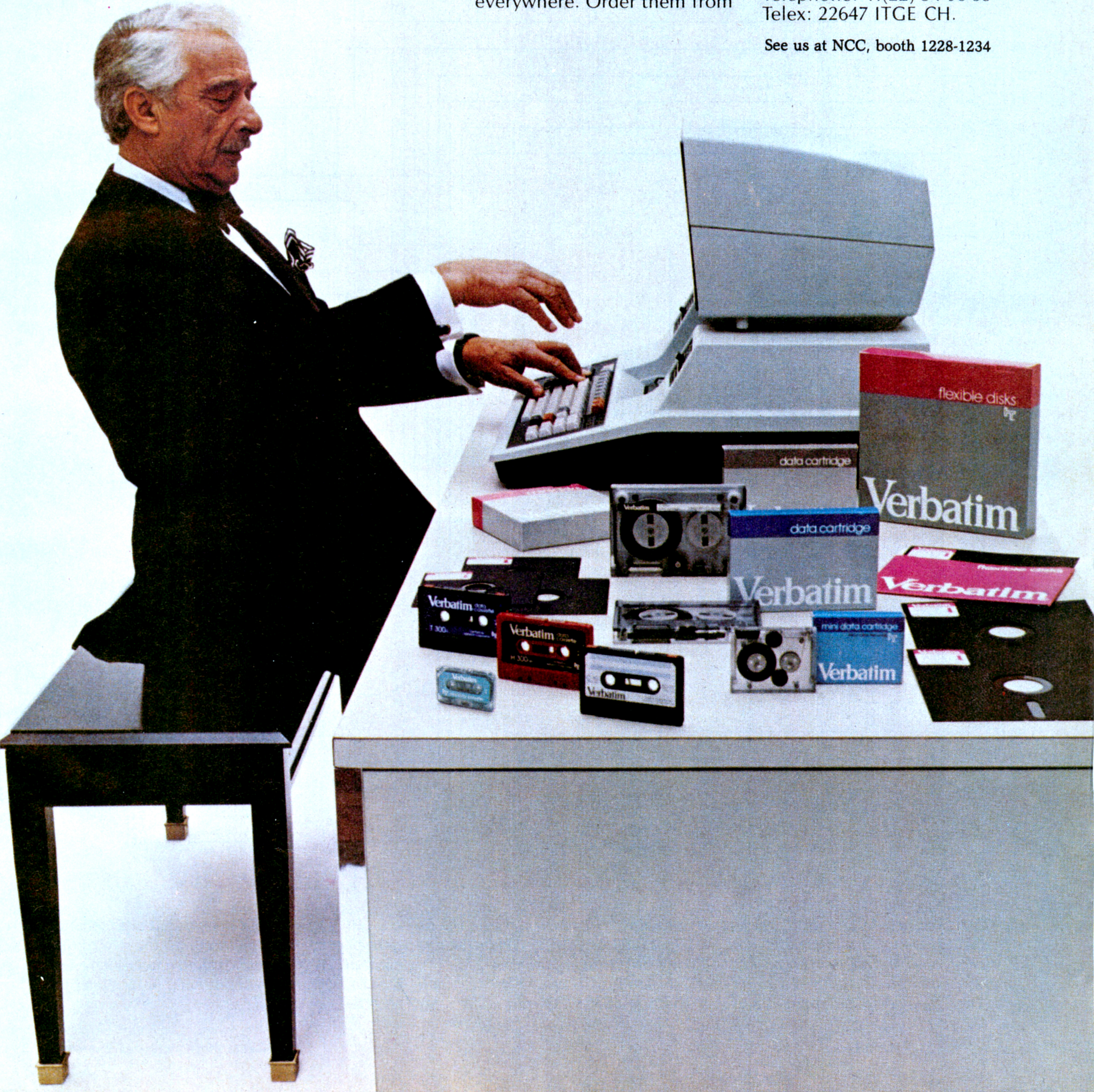
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data cartridge
Verbatim
data cartridge
Verbatim
Verbatim
mini data cartridge
Verbatim

Number	Type	+5 V	GND
IC1	74LS125	14	7
IC2	74LS125	14	7
IC3	74LS75	5	12
IC4	74LS75	5	12
IC5	74LS155	16	8
IC6	74LS04	14	7
IC7	74LS04	14	7
IC8	74LS30	14	7

Text continued from page 30:

is not configured to be easily interfaced to the projects I present each month. The widely sold Level II BASIC, 16 K-byte memory version has no parallel I/O capability, aside from the single-bit cassette-motor control. With the addition of the expansion interface, the user gets one parallel output port and one half (ie: 4 bits) of an input port. If these ports are used, as Radio Shack intends, to drive a printer, then the only way to provide usable parallel I/O capability is to add a separate I/O interface.

Considering the pertinent elements of the previous discussions, it is easy to construct both parallel input and

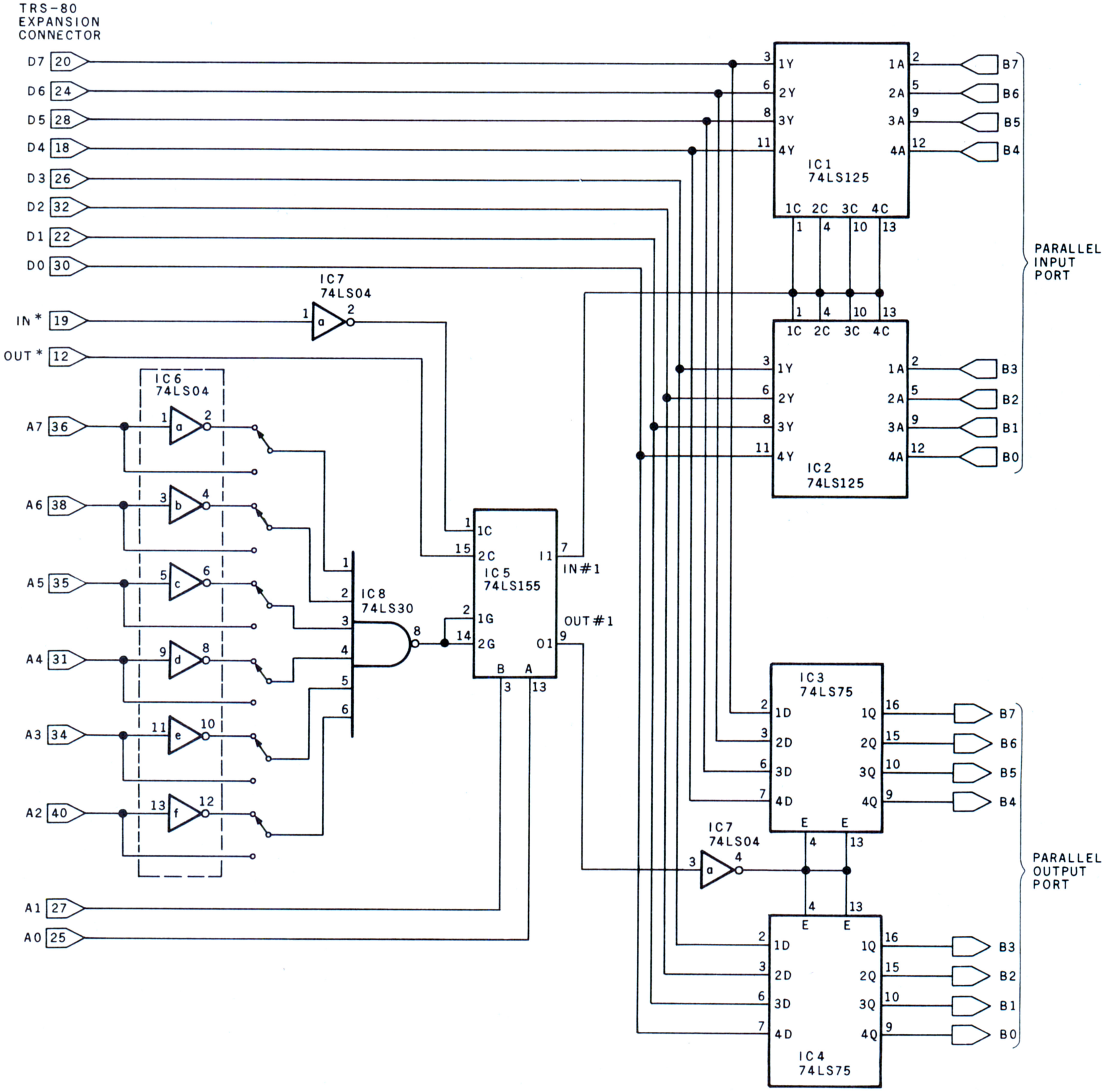
TRS-80 EXPANSION CONNECTOR
D7 20
D6 24
D5 28
D4 18
D3 26
D2 32
D1 22
D0 30
IN* 19
OUT* 12
A7 36
A6 38
A5 35
A4 31
A3 34
A2 40
A1 27
A0 25
IC7 74LS04
IC6 74LS04
IC8 74LS30
IC5 74LS155
1C 2C 1G 2G B A I1 O1
IN#1
OUT#1
IC1 74LS125
1Y 2Y 3Y 4Y 1A 2A 3A 4A
1C 2C 3C 4C
IC2 74LS125
B7 B6 B5 B4 B3 B2 B1 B0
PARALLEL INPUT PORT
IC3 74LS75
1D 2D 3D 4D 1Q 2Q 3Q 4Q E E
IC4 74LS75
PARALLEL OUTPUT PORT

Figure 7: *A complete, economical, parallel I/O interface circuit for use with the Radio Shack TRS-80 computer, or with other computers that use a similar bidirectional data bus. This interface can be connected directly to the expansion connector at the rear of the TRS-80 keyboard/processor unit, or it can be connected through the expansion-interface unit. As the circuit is shown here, there are six presently undefined additional strobes available on IC5. These six strobes can be used to support three additional ports. Refer to figure 3 and figure 4 to determine the proper selection of the I/O port address for this interface.*

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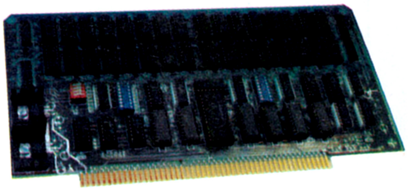

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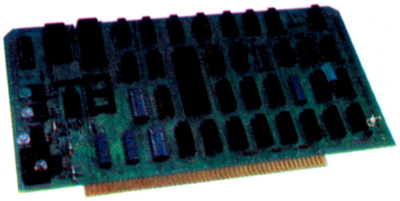

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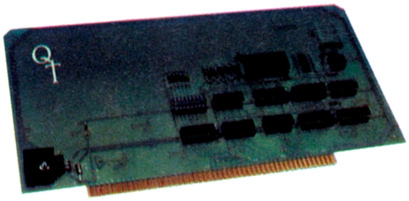

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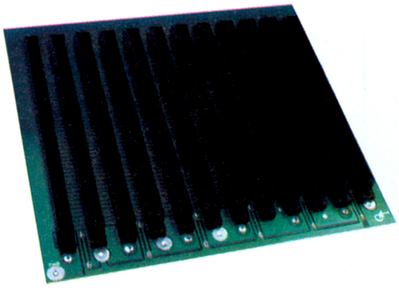

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parallel output ports for the TRS-80. The interface shown in figure 7 provides one input and one output port. The signals necessary to drive this interface are available on the forty-pin expansion connector of the keyboard/processor unit or on connector J2 on the expansion interface. In either case, a separate +5 V supply is necessary to power the circuit. The signals on the expansion connector are listed in table 1, and the pinouts are shown in figure 8.

Pin Number	Signal Name	Description
1	RAS*	row-address strobe output for 16-pin dynamic memories
2	SYSRES*	system-reset output, low during power-up initialization or when the reset switch is depresssed
3	CAS*	column-address strobe output for 16-pin dynamic memories
4	A10	address output
5	A12	address output
6	A13	address output
7	A15	address output
8	GND	signal ground
9	A11	address output
10	A14	address output
11	A8	address output
12	OUT*	peripheral-write strobe output
13	WR*	memory-write strobe output
14	INTAK*	interrupt-acknowledge output
15	RD*	memory-read strobe output
16	MUX	multiplexer control output for 16-pin dynamic memories
17	A9	address output
18	D4	bidirectional data bus
19	IN*	peripheral-read strobe output
20	D7	bidirectional data bus
21	INT*	interrupt input (maskable)
22	D1	bidirectional data bus
23	TEST*	placing a logic 0 on this line causes a high-impedance condition on address lines A0 thru A15, data lines D0 thru D7, WR*, RD*, IN*, OUT*, RAS*, CAS*, and MUX
24	D6	bidirectional data bus
25	A0	address output
26	D3	bidirectional data bus
27	A1	address output
28	D5	bidirectional data bus
29	GND	signal ground
30	D0	bidirectional data bus
31	A4	address bus
32	D2	bidirectional data bus
33	WAIT*	processor-wait input, to allow for slow memory
34	A3	address output
35	A5	address output
36	A7	address output
37	GND	signal ground
38	A6	address output
39	—	on Level I machines: low-current +5 V output on Level II machines: no connection
40	A2	address output

Table 1: *Description of function for the pins on the expansion port at the rear of the TRS-80 keyboard/processor unit. This pin assignment is also used in expansion slots in the expansion-interface unit. This information is provided through the courtesy of Radio Shack, a division of Tandy Corporation.*

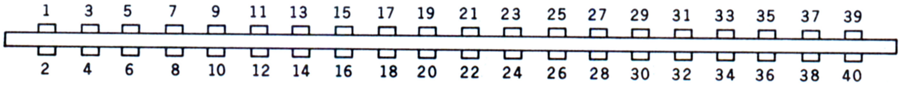

Figure 8: *The configuration of output pins on the expansion port on the rear of the TRS-80 keyboard/processor unit. See table 1 for an explanation of the function of each pin.*

The schematic diagram of figure 7 shows a port address FF. To set another port address simply refer to figure 3 and 4 and place the switches for the proper code.

I hope to enable many TRS-80 owners to build this I/O circuit and to use it to attach other "Circuit Cellar" projects to their computer systems.

There are many other methods for implementing I/O capability. An 8255 programmable peripheral interface, a parallel I/O device, could have been used. The circuit I have chosen to present is intended to be inexpensive and easy to operate. By minimizing potential parts-acquisition problems and keeping down the software handshaking necessary when using large-scale circuits like the 8255, I hope to enable many TRS-80 owners to build the circuit and use it to attach other "Circuit Cellar" projects to their computer system.

Those experimenters who hesitate to build hardware might want to purchase the entire communications interface. An assembled and tested unit, with power supply and containing a parallel port (for the Centronics printer) and a serial RS-232C-compatible interface, is available. The complete communications unit, called the COMM-80, will be presented in part 2 of this article and is available for $179.95 from:

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Next Month

I shall complete the COMM-80 presentation by discussing the construction of a software-compatible RS-232C interface for the TRS-80 that has selectable data rates from 50 to 19200 bps. ■

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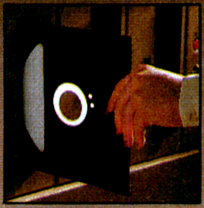

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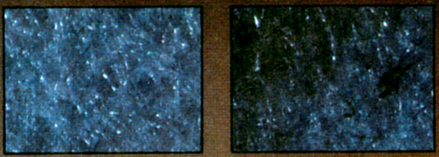

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Joel Swank
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Any owner of the MOS Technology KIM-1 knows the utility of the KIM's built-in audio-cassette interface. But, any KIM-1 owner who has expanded his system knows just as well how inappropriate the cassette is for storing long files. The standard KIM cassette format is intolerably slow, and even using the Hypertape method (a faster cassette-storage format for the KIM), a 4 K-byte file takes a minute and a half to load, not counting the time needed to position the tape.

The natural storage alternative is, of course, the floppy disk. However, there are some difficulties. A floppy-disk system requires a considerable amount of software to make it useful. In addition, many floppy-disk systems available today come with proprietary software for the 8080/Z80 or 6800 processors. Interfacing such systems to a KIM-1 requires the hobbyist to write his or her own 6502 software, working from the machine code for the other processor. While it is possible to do this, few hobbyists are willing to translate machine code to get their disk system up and running.

I decided to interface a Percom LFD-400 disk system to my KIM-1. The LFD-400 system contains a disk controller capable of controlling up to three 5-inch floppy-disk drives. It comes with complete, annotated source code for the 1 K-byte MINIDOS disk-operating system, written for the 6800 processor. MINIDOS allows the reading and writing of contiguous memory files, and is the nucleus of MINIDOS-PLUSX, a 6800-based disk-operating system sold by Percom.

KIMDOS is a KIM-1-compatible version of the Percom MINIDOS. It allows a KIM-1 to read and write files that are compatible with the Percom format. This article will concentrate on explaining the workings of the KIMDOS software. The LFD-400 system easily interfaces to the bus lines of any KIM-1 system (see table 1); because of this, hardware interfacing will not be discussed here.

The LFD-400 uses hard-sectored disks with ten 256-byte sectors per track and thirty-five tracks per disk. This gives 87.5 K bytes of usable data per disk. The controller board has sockets for up to 3 K bytes of 2708-type erasable programmable read-only memory (EPROM). KIMDOS has been written to fit in one 2708 device.

The controller board requires unregulated power supplies of +14 V, −14 V, and +8 V; or regulated power supplies of +12 V, −5 V, and +5 V. The controller is

Photo 1: *The author's personal computer system. It contains the following commercially built equipment: a MOS Technology KIM-1 microcomputer, three 8 K-byte Digital Group static memory boards, a Percom LFD-400 floppy-disk controller and two Shugart 5-inch floppy-disk drives, a Southwest Technical Products Corporation GT-6144 graphics board, an ACT-IA terminal with Leedex monitor, an Olivetti TE-300 hard-copy terminal, and several Lambda power supplies. Homebrew equipment in the system includes a programmer for erasable programmable read-only memories (EPROMs), a programmable integrated-circuit tester, a calculator interface, the motherboard, and the input/output (I/O) interface board.*
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composed of twenty-seven transistor-transistor logic (TTL) integrated circuits and the Z5023 universal synchronous receiver/transmitter (USRT) on a 15.24 by 25.4 cm (6 by 10 inch) two-sided printed-circuit board. Low-power Schottky (LS) components are used to reduce power consumption and minimize bus loading.

LFD-400	KIM Connector	Function	Comments
9	E-7	RST	
10	E-V	R/W	
11	E-22	$\overline{\text{VMA}}$	VMA always true on KIM-1
12	E-U	ϕ_2	
19		+14 V	or use regulated +12 V
20		−14 V	or use regulated −5 V
21		+8 V	or use regulated +5 V
22		+8 V	
23		+8 V	
24	E-22	ground	
25		ground	
26		ground	
27	E-A	A0	
28	E-B	A1	
29	E-C	A2	
30	E-D	A3	
31	E-E	A4	
32	E-F	A5	
33	E-H	A6	
34	E-J	A7	
35	E-K	A8	
36	E-L	A9	
37	E-M	A10	
38	E-N	A11	
39	E-P	A12	
40	E-R	A13	
41	E-S	A14	
42	E-T	A15	
43	E-8	D7	
44	E-9	D6	
45	E-10	D5	
46	E-11	D4	
47	E-12	D3	
48	E-13	D2	
49	E-14	D1	
50	E-15	D0	

Table 1: *Hardware connections from the KIM-1 single-board computer to the Percom LFD-400 disk-drive controller. Also given is the function of each line used.*

Floppy-Disk Drive

The Shugart 5-inch floppy-disk drive comes assembled and tested from Percom. A copy of the Shugart instruction manual is included in the system documentation; it is thirty-three pages long, and contains schematic diagrams and complete specifications for the drive and its operating principles. Troubleshooting procedures are also detailed.

Each disk drive must be set up to respond to a specific drive number. This programming is accomplished by plugging a shunt block into a fourteen-pin dual-in-line pin (DIP) socket. A seven-pole DIP switch can replace the shunt block; the drive numbers may be easily changed using the switch.

Because the Shugart floppy-disk drive allows only three drive-select lines, the controller board in the Percom LFD-400 system uses only the drive-select lines that are numbered 01 thru 03. A drive-select line for device 00 exists, and can be selected by the KIMDOS software; however, this line is not usually connected to anything. With the addition of the proper jumpers to the controller and disk-drive boards, a four-drive disk system can be configured using device numbers 00 thru 03. The Micropolis disk drive could be used for this purpose, since it has a fourth drive-select line on pin 34 of the thirty-four-pin ribbon cable.

Functions of the Controller

The LFD-400 uses a crystal oscillator to time the data and clock bits from the drive. The data is separated from the clock bits and is shifted into the universal synchronous receiver/transmitter. The USRT latches each 8-bit byte and sets a flag to notify the processor to read the byte. For a write operation, the USRT sets a flag when it is ready to receive data from the processor. After the processor has stored the data in the USRT, the data is shifted out, merged with the clock bits, and is sent to the drive.

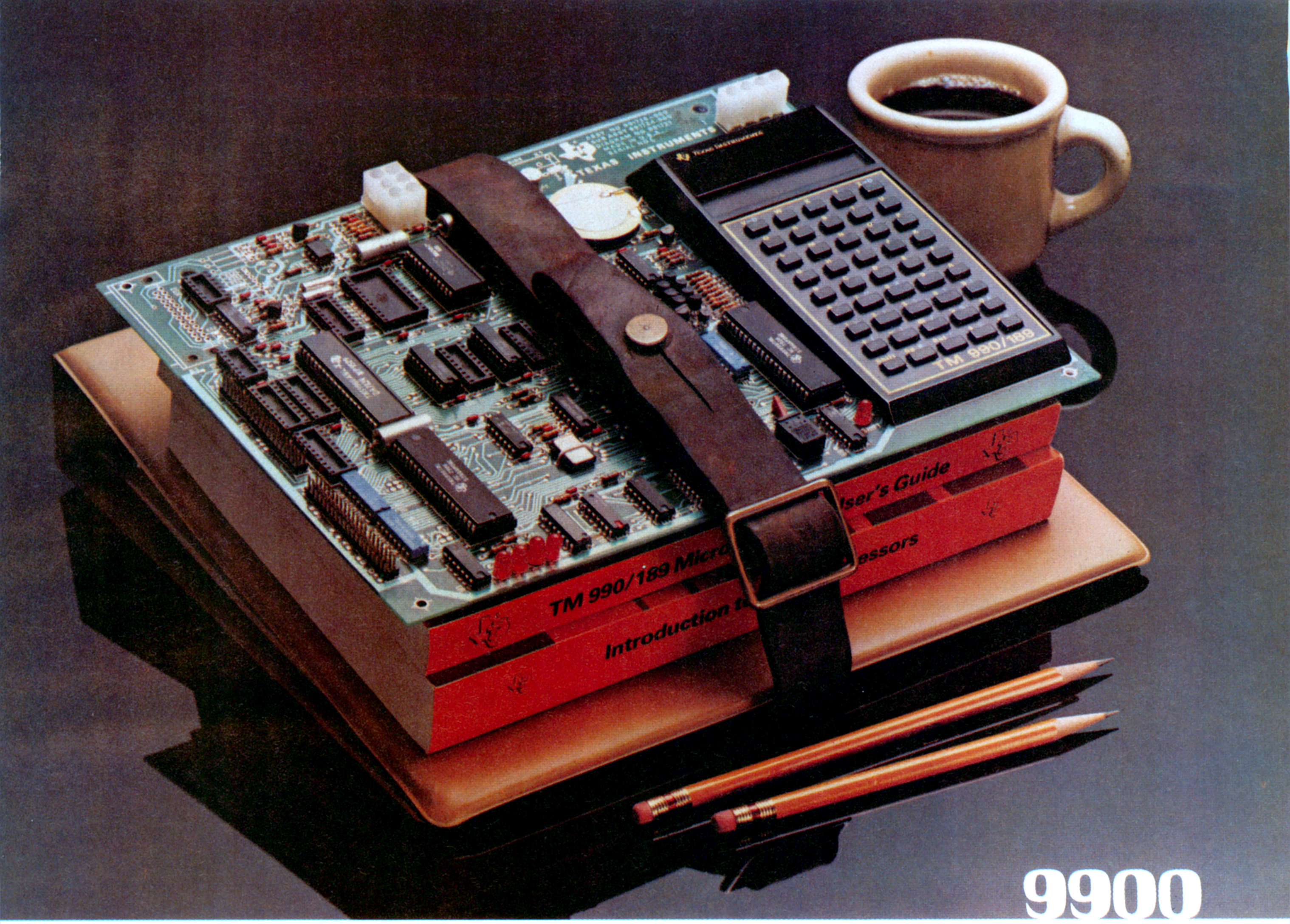
The controller also takes care of maintaining the current sector count. The motor-control circuit contains a monostable multivibrator (commonly called a one-shot) that turns the motor off after about 3 seconds of nonuse. The drive select is a 2-bit number that is latched and decoded to select one of three drive-select lines, as discussed previously. The drive-select line for device 00 is not used. The step and direction bits are also latched. The track-0 and the write-protect lines are buffered for the microprocessor. Address decoding is provided for all controller addresses and for the 2708s. The data bus is buffered with 8835 three-state buffer devices.

Hardware Modifications

The only incompatibility between the KIM-1 and the LFD-400 lies with the use of a "low-true" logic convention on the SS-50 data bus. In the low-true convention, a voltage potential of 0.4 V or less is regarded as a true or binary 1 logic signal. This convention is used because the 8835 devices are *inverting* buffers.

The KIM-1 uses a high-true convention on its data bus; potentials of 3.5 V or greater are regarded as a true or binary 1 logic condition. To remedy this problem, I replaced the 8835 buffers with their noninverting counterparts, 8833 buffers. Since the disk-controller board does not have sockets, the 8835s had to be unsoldered. An alternative method would have been to write software that accepts and translates the inverted data coming from the controller, but the software method seemed more difficult and error-prone than the hardware method of replacing the three-state buffers.

My KIM-1 system has regulated voltage sources of +5 V, −12 V, and +12 V. I chose to bypass the



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LFD-400 regulators for +5 V and +12 V and drive the circuits that require these voltages directly from the system power supply. I fed the −12 V source into the −5 V regulator on the LFD-400 to obtain that regulated voltage.

The only other modification required was due to a problem with the oscillator circuit, which did not always start when the system was powered up. To correct this, I short-circuited the 0.001 μF capacitor near the crystal, effectively removing it from the circuit. According to the engineers at Percom Data Corporation, no one else has reported this problem.

There are five ten-pin Molex connectors on the controller board. Mates for these are available from Percom; however, it may be more convenient to simply remove the Molex connectors and replace them with another type. The pin numbers on the controller board and the KIM-1 equivalents are given in table 1.

2a

Hexadecimal Address	Function When Used as Input
CC00	Read USRT status: bit 0 = 1 means disk unit ready to send byte to computer at address CC01 during read operation bit 7 = 1 means disk unit ready to receive byte from computer at address CC01 during write operation
CC01	Address used to transmit data from disk drive to computer during read operation
CC02	During read operation, bits 0 thru 3 contain current sector number in binary
CC03	Drive status byte : see table 2b.
CC04	Accessing this location with a load instruction (LDA) causes a read operation to take place

2b

Bit	Value	Meaning
0	1	Write-protect notch in disk covered; disk is protected
1	1	Head is at track 0
2	0	Drive motor is on
3	0	Drive circuit is ready to write to disk
4	1	Sector pulse; drive detects sector hole
5	1	Index pulse; drive detects special index hole
6,7		Binary number of drive selected (01 thru 03)

Table 2: *Memory addresses used by the LFD-400 disk-controller board. Communication takes place between the disk and the computer via memory-mapped bytes as listed. Table 2a gives the function of 5 bytes used for input from disk to computer. Table 2b defines the permissible values of bits in the drive-status byte (hexadecimal location CC03). Table 2c gives the function of 7 bytes used to control output from the computer to the disk.*

2c

Hexadecimal Address	Function When Used as Output
CC00	Defines value that controller will recognize as the SYNC byte at the beginning of a read operation; hexadecimal FB used in Percom format
CC01	Address used to transmit data from computer to disk unit during write operation
CC02	Defines value that controller will recognize as the filler byte (written after trailer until disk motor turns off); hexadecimal FF used in this software
CC03	Data to select drive and head-movement direction: bit 4 = direction of head movement: 1 = in, 0 = out bit 5 = step pulse bit; causes data-transfer head to jump to next track in direction given by bit 4 bits 6, 7 = binary number of drive to be selected
CC04	Accessing this location with a store instruction (STA) causes a write operation to take place
CC05	Accessing this location with either a load (LDA) or store instruction causes a motor-on pulse to be sent to the disk drive
CC06	Accessing this location with either a load or store instruction causes a motor-off pulse to be sent to the disk drive

Software and Hardware Interaction

All communication between the microprocessor and the disk controller takes place through hexadecimal memory addresses CC00 thru CC06. Because address lines A4 thru A9 are not decoded, addresses as low as hexadecimal CC10 to CC16 and as high as hexadecimal CFF0 to CFF6 also respond identically; but these addresses are not used. A complete list of controller addresses and functions is found in table 2.

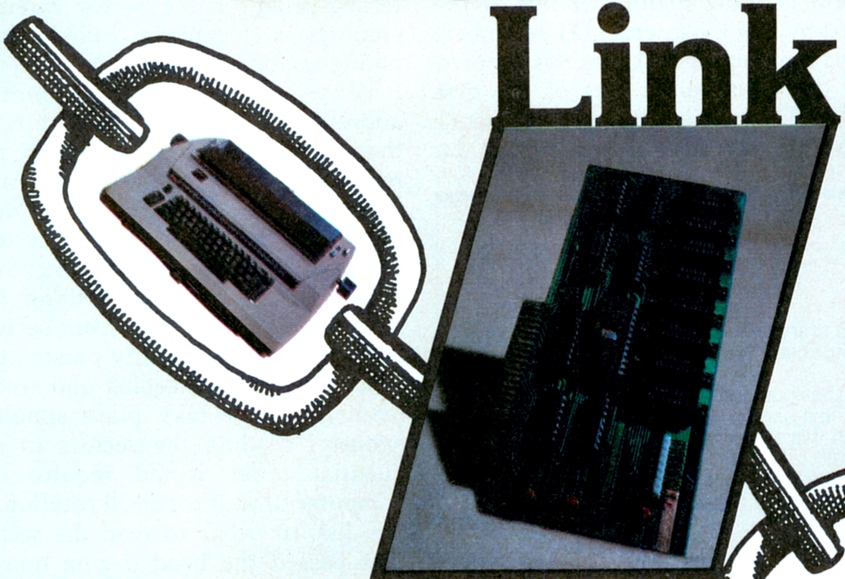
The data on each floppy disk is arranged in thirty-five *tracks* or concentric circles. The motor rotates the disk at 300 rpm — one rotation takes 200 ms. Each track is divided into ten sectors in this hard-sectoring scheme.

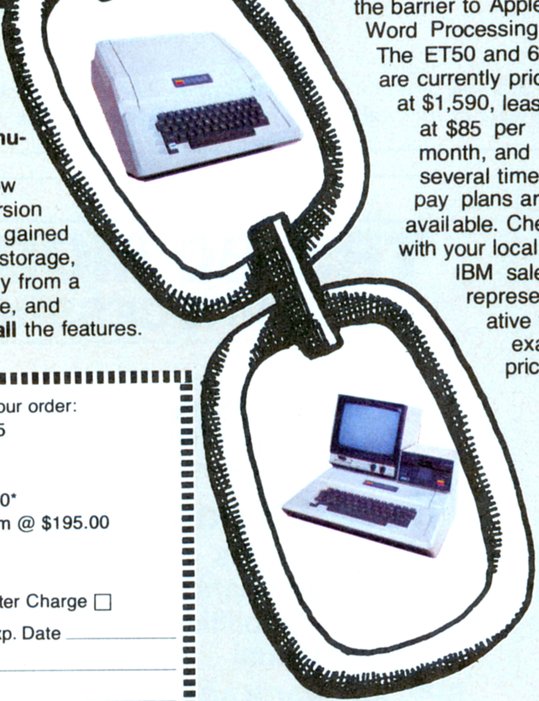
In *hard sectoring*, the sector boundaries are detected by means of physical holes punched through the recording surface of the disk. As the disk rotates, these holes pass between a light-emitting diode (LED) and a photoelectric detector. Percom floppy disks have ten sector holes evenly spaced around the hub hole of the disk, with a single additional *index hole* placed halfway between two of the sector holes. This index hole is used to identify one sector on the disk as sector 0. Timing circuits in the controller detect the shorter distance between holes when the index hole passes the photodetector. When the index hole is detected by this method, the sector counter is reset.

Each sector occupies one tenth of the circumference of a track on the disk and passes across the disk data-transfer head in 20 ms. Data is written to the disk at a rate of 1 byte every 64 μs, theoretically giving room for up to 312 bytes per sector. It is not possible to fully use these 312 bytes. The Percom format uses a maximum of 287 bytes for leader, header, useful data, and trailer, with the data length variable from 1 to 256 bytes. Table 3 details the format of data stored in each sector.

Each track on the disk has ten sectors. The sectors are numbered in decimal from 000 to 349. In this three-digit numeral, the two high-order digits denote the track number in

The Missing Link





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For use in actual disk-addressing operations, the external DTS number is reformatted into a binary, *internal* drive/track/sector number. The internal DTS number has the following properties. The number of the disk drive (1 thru 3) is stored in binary form in the 2 high-order bits of the first byte of the internal DTS number. The track number (1 thru 34) is stored in the 6 low-order bits of the first byte. The individual sector number (1 thru 9) is stored in binary form in the second byte.

Field Name	Length in Bytes	Contents
Leader	16	Binary zeros
Sync	1	Hexadecimal FB to indicate start of data
Current DTS number	2	Drive/Track/Sector numbers of this sector
Backward link	2	DTS number of previous sector in file
Forward link	2	DTS number of next sector in file
Byte count	1	Length of data in this sector, in hexadecimal (00 means hexadecimal 100)
Target address	2	Address of memory from which data was written
File type	1	Indicator of the nature of the data
Data	1 to 256	Data being stored
Check sum	2	2-byte cyclic redundancy check sum of all bytes after sync byte
Trailer	2	DTS number of first sector of this file, or execution address if this is last sector in this file

Table 3: *Table of sector fields and format. The drive/track/sector (DTS) number, stored here in internal binary format, points to a given sector.*

While the reformatting of the drive and track numbers from external to internal format involves only a simple decimal-to-binary conversion, the reformatting of the sector number employs a technique called *alternating-sector addressing*.

Why is alternating-sector addressing necessary? The sectors of the spinning disk pass under the read/write head consecutively, and there is no time between sectors during which the disk-operating system can perform housekeeping functions. While KIMDOS is performing the housekeeping routines for one sector, the next sector is already passing the head. Since housekeeping and sector reading cannot take place simultaneously, reading the sectors in sequential order would require the computer to wait for a full rotation of the disk to occur to read the sector that passed the head during housekeeping. Since every sector must be treated this way, only one sector could be read during each rotation of the disk if sectors were to be read sequentially. To remedy this problem, the sequential sector numbers are converted into alternating sector numbers.

KIMDOS reads or writes alternate sectors on the disk; the disk must rotate twice for all sectors on the track to be read or written. The order of physical sectors is therefore not the order of logical sectors. In the two complete rotations of the disk, the physical sectors are read in the following order: 0, 2, 4, 6, 8 (first rotation); 1, 3, 5, 7, 9 (second rotation). Sectors are accessed alternately to allow time in between data-transfer operations for executing housekeeping routines.

Each sector contains a *sector header* that holds information about the sector and the file of which it is a part. The first two bytes of the sector header contain the DTS number of the current sector; this is used to assure proper head position when reading. Each sector is linked via a forward pointer to the next sector and via a backward pointer to the previous sector. A forward pointer equal to 0 indicates the last sector in a file; a backward pointer equal to 0 indicates the first sector in a file.

The header also contains a data-length byte, a file-type byte, and the

Text continued on page 158

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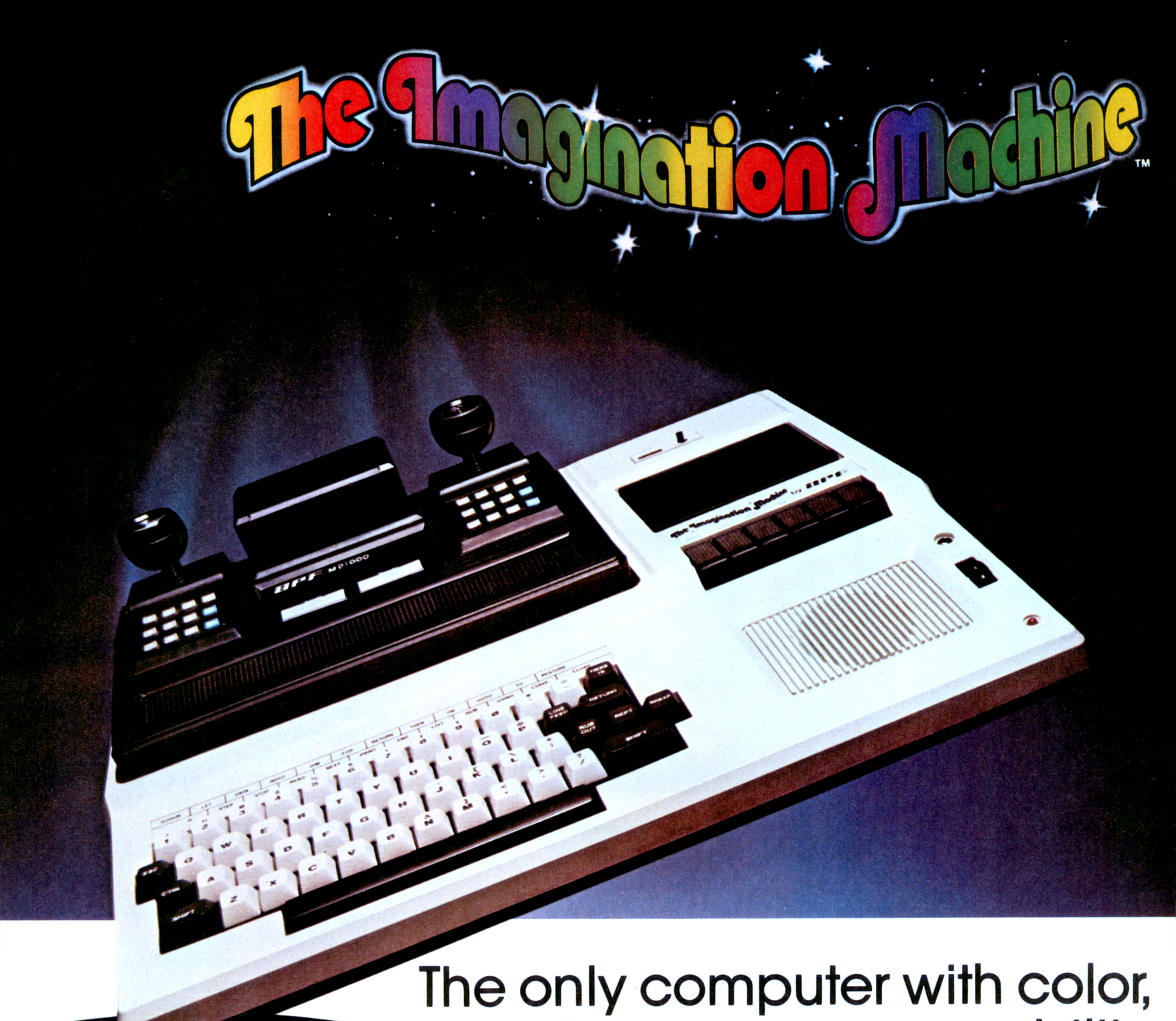

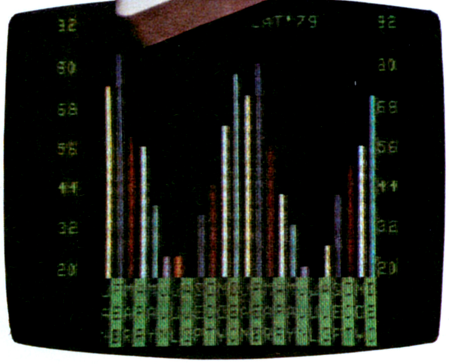

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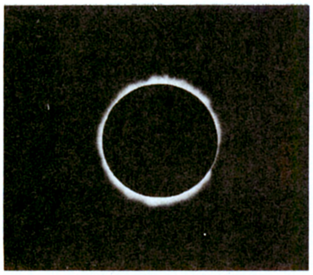
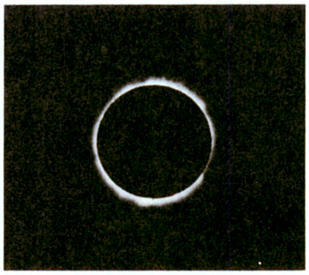
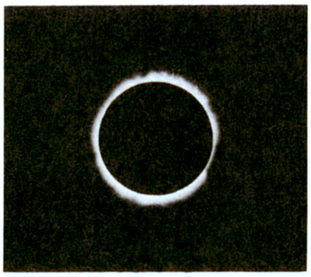


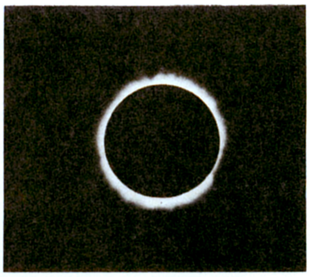
(3a) 1 millisecond



(3b) 2 milliseconds



(3c) 5 milliseconds



(3d) 10 milliseconds

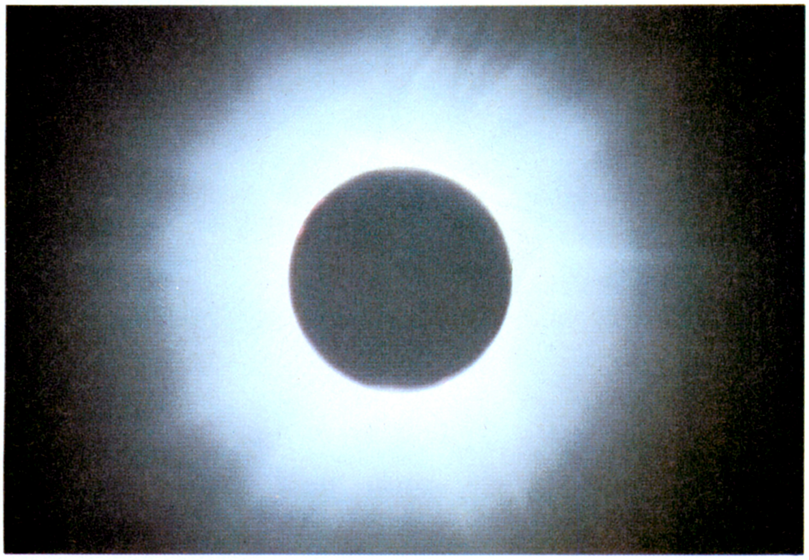


Photo 1: *A 5-second exposure with ASA 64 Ektachrome brings out significant coronal detail twice per 25-exposure cycle.*

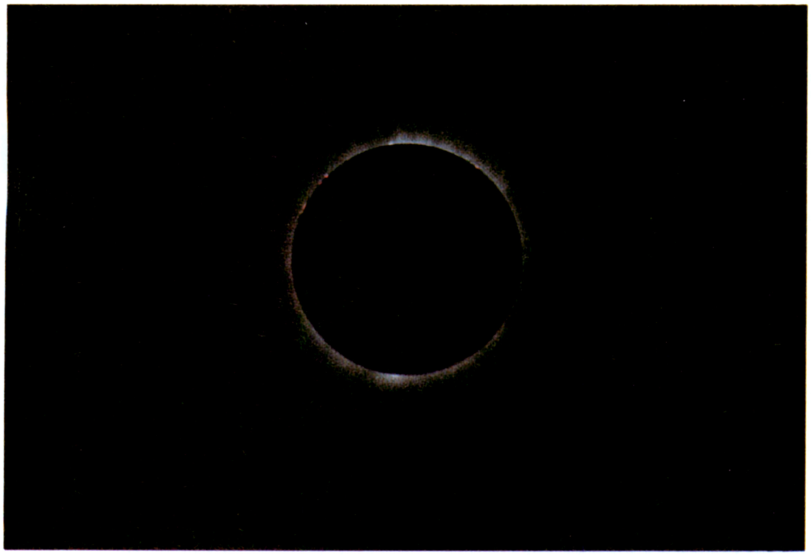


Photo 2: *A minimal length exposure shows the beginnings of some prominence detail and the inner corona. This exposure corresponds to the shortest nominal exposure time, 1 ms plus the minimum trigger-pulse width of 20 ms. The electromechanical system which is the Nikon MD-2 Motor Drive unfortunately has a minimum shutter-open time on the order of 20 ms. Thus the exposures nominally programmed at 1, 2, 5, and 10 ms were actually on the order of 21, 22, 25, and 30 ms.*

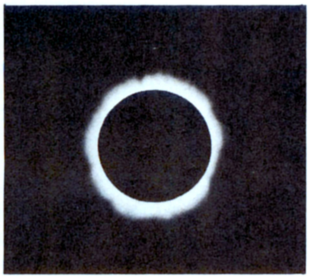
Text continued from page 6:

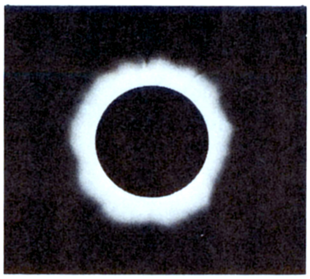
With this crucial timing step completed, I turned my attention to refining the Pascal program shown as listing 1 in the March 1980 BYTE editorial. These refinements included one conceptual change and some trivial changes in the experiment's design.

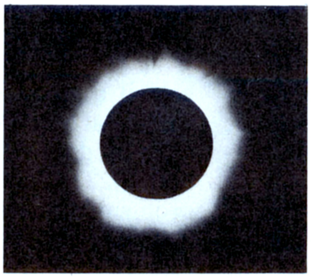
The conceptual change was that of adding a single long exposure made during the "slack time" interval at the end of the eclipse sequence during totality. As noted earlier, the model for the eclipse photography sequence used two manual inputs: one to start a sequence of diamond-ring exposures followed by automatic totality photography, and a second manual input to start the final diamond-ring sequence after a "slack time" for synchronization. My conceptual change was to open the shutter of the camera during this slack time, thus allowing one extremely long exposure to take place while waiting for the second manual input. Thus by specifying a smaller number of exposures during totality and a longer slack time, I would obtain this one long exposure.

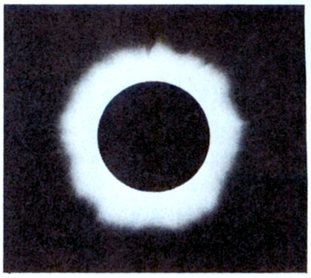
The relatively trivial changes began with the alteration of the table of exposure times to provide a total of twenty-five different times instead of ten. In making this change I used the UCSD text editor to change the name of the table in every occurrence throughout the program. I also changed the initialization to provide a 1, 2, 5 sequence of exposure times in each decimal order of magnitude. (See photo 3's captions for the values resulting.)

Another relatively minor change was to allow multiple tries at allocation of the exposures, rather than falling inexorably into a run of the photography sequence. This change proved quite useful in the field where it provided a means of verifying that


(3e) 20 milliseconds


(3f) 50 milliseconds


(3g) 0.1 second


(3h) 0.2 second

the computer had not died in the last minutes prior to totality. The program also had to be modified to talk to a 40-character-wide field on the Apple II video display instead of the 80-character width available on the terminal I normally use. This change amounted to condensation of the texts displayed during the allocation procedures. The final form of the program as used by the shores of Lake Jipe on February 16, 1980 is shown in listing 1.

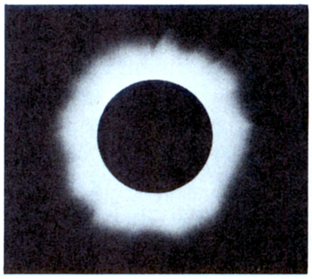
The final equipment check prior to leaving was the verification that the display on a 2-inch diagonal Sanyo television screen was adequate. A jumper cord once used to interface between a tape recorder and my old homebrew computer provided the means for routing the output of the Apple's auxiliary RF modulator to the Sanyo television. The display wavered a bit when running on the portable generator. It was a tiny display but adequately readable for my purposes.

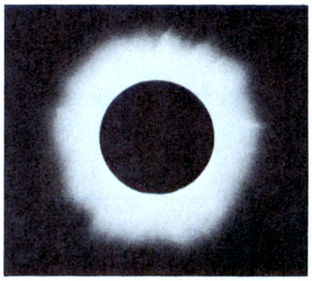
After this crucial experiment, the final detail was to make redundant copies of my eclipse application program's disk, as well as the UCSD Apple Pascal system's disks Apple1, Apple2, and Apple3. Redundancy was important. If I were to have a directory crash due to dust or dirt while on the other side of the equator 11,000 miles from home, a second chance would have been well worth it.

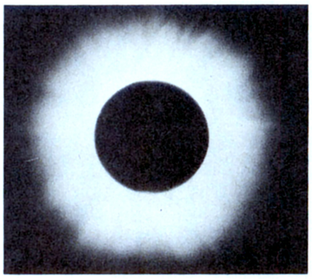
On Tuesday morning February 5, we hastened to Boston where the air travel to Kenya began with a trip to New York's Kennedy Airport. The party at this time consisted of myself, Tully Londoner, Norm Whyte, and Laurel Allen. Rick Lutman, the fifth member of our party, would join us in Nairobi. In due course we boarded Pan American's flight 190, an 18-hour international puddle jumper with stops at Roberts Field, Liberia, and Lagos, Nigeria. The computer equipment and telescope mount in addition to trunks and pack frames full of clothes, sleeping bags, and tools constituted our luggage.

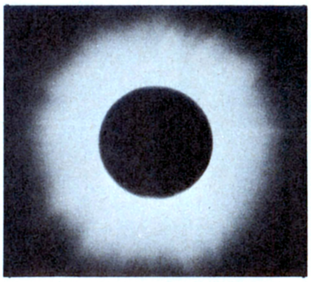
On reaching Nairobi at about 8 PM that Wednesday, we met our guide, Iain Allan, and his associate Vince Fayad. Iain does business as Tropical Ice (Mountain Guides) Ltd, Post Office Box 57341, Nairobi, Kenya. Making the connection with Iain was the only redeeming virtue of an otherwise hopelessly botched set of travel arrangements made by our US travel agents (who shall remain anonymous). Iain was our guide to the wilds of Kenyan culture for the next two weeks. His good humor and knowledge of local flora, fauna, and climate are highly recommended to anyone traveling in East Africa for purposes of game trekking or technical mountain climbing. Iain wrote the guidebook on Mt Kenya and other climbs in Kenya. He also frequently guides technical climbing trips on Tanzania's Kilimanjaro, when not tackling various other challenging rock climbs in places as diverse as Nepal and Yosemite.

As in any trip of this kind, there were some difficulties. The most significant (and in retrospect, completely avoidable) difficulty was the need to post a 30,000 shilling bond on our equipment with Kenyan customs on entry. We later had to recover our customs bond on departure (minus an exorbitant 10% fee exacted by the local branch of a major US multinational bank). The fact that we had to post a bond at all was due to an un-


(3i) 0.5 second


(3j) 1.0 second


(3k) 2.0 seconds


(3l) 5.0 seconds

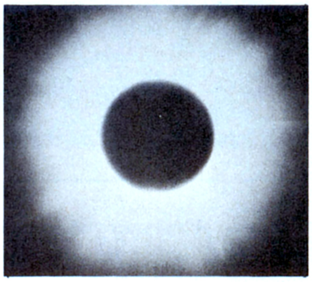

(3m) 10.0 seconds

Photo 3: *Black and white reproductions of the entire series of different exposures taken with the aid of the final version of the Pascal control program for the camera. Times are nominal shutter-open intervals stored in a table in the program. Actual times reflect a fixed lower-limit overhead of approximately 20 ms.*

fortunate mistake by one of our party, a slipup which can possibly be avoided by readers in similar circumstances.

When listing personal computer equipment being carried for such an expedition, never ever list its monetary value or speak of its value. To satisfy US customs, all you need is a list of serial numbers of your personal equipment carried abroad. This list can be used to advantage when entering another country. But if you give the customs officer at another country the list of items and values you prepared for your insurance agent, it is like waving a red flag in front of a bull.

We had to post a customs bond on Norm's equipment using credit cards to obtain nearly $4000 in cash, then retrieve the cash bond at the end of the trip by pleading lack of time to Kenyan customs officials in order to get all the paperwork completed by our departure. We wasted two out of sixteen days figuring out all the "catch-22"-style sophistries of this problem.

Kenya is a very British relic of a former era, where dual languages of Swahili and English dominate. Iain pointed out that it would have been much more complicated in several countries in which he has traveled for purposes of mountain climbing. In one Asian country he has visited for climbing, Iain points out, there is not even a recognizable set of paperwork to be filled out. It was quite a relief to get back to a (relatively) sane United States at the end of the trip.

So much for the bureaucratic problems of taking computers abroad to equatorial Africa. What about the engineering problems? We did as thorough a job of preparation as we could, yet would the computers and generator still play together when we reached our final encampment on the shores of Lake Jipe in Kenya's Tsavo West National Park?

We answered this question by an ancient technique: crossing fingers and applying power. We arrived at Lake Jipe 2 days before the eclipse, after a 6-hour trek over some incredible roads in Iain's Volkswagen bus with trailer in tow. The computers were inside the bus with seven human bodies and food packed with solid CO_2 in the famous Tropical Ice Box. All the rest of our gear was carried in the trailer. The roads we traveled from Amboseli to Lake Jipe included one 5-mile stretch of a semi-improved lava flow, an unmarked dead end which looked like the main road of two alternatives, and other miscellaneous "hazards" like herds of elephants and troops of baboons.

The day before the eclipse, Norm

Photo 4: *A view of the equipment set up at the Tsavo West National Park campsite on the shores of Lake Jipe. Norm was using a 500 mm reflex lens with his camera; I was using my 1000 mm reflex lens. The two Nikon cameras were mounted on the equatorial telescope mount carted to Africa along with the 110 VAC generator in Norm's homebrew plywood shipping trunk. The Apple Pascal system is shown sitting in the bottom of its carrying case on top of a trunk.*

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Listing 1: *This is the final version of my Pascal Eclipse Control Program as used in Kenya, February 16, 1980. Major changes from the previously published version include filling in the details of real-time execution and modifying the exposure table to provide twenty-five shots instead of ten. Also added was an interactive option to reenter the the exposures allocation phase so that different combinations of diamond ring and totality exposures could be tried. Initialization now puts in a symmetrical rising and falling sequence of exposure times from 1 ms to 10,000 ms. All interactive texts have been adjusted so that they will fit the 40-character width of the Apple's built-in video display.*

```
{     N O T E S   A B O U T   T H E   D E S I G N   P R O C E S S    }
{}
{     Step 1: High Level Description  - begun November 22, 1979      }
{          This is a first cut at a program to simulate the eclipse  }
{       photography process, and define some of the necessary global }
{       data of the problem.                                         }
{                       COMPLETED 11/24/79                           }
{}
{     Step 2: Fill in allocation details -                           }
{          Achieve a complete allocation of the eclipse camera con-  }
{       trol function as evidenced by calculation of a detailed time }
{       line for the eclipse event given various conditions:         }
{               Given:                                               }
{                  n    = number of totality exposures               }
{                  m    = number of diamond ring exposures           }
{                  t    = totality time                              }
{                  s    = slack in allocated totality time           }
{               Then let us seek the following...                    }
{                * d2   = diamond ring time at 2nd contact           }
{                * d3   = diamond ring time at 3rd contact           }
{                * z    = extra slack (one half of diamond ring total)}
{                * p    = anticipation time (half first diamond ring) }
{                * A    = required time for exposures during totality }
{                * a    = allocated totality time for exposures      }
{                * x    = margin per frame in totality               }
{               Theorems:                                            }
{                  d2,d3 derived from table of diamond ring frames   }
{                  A    derived from table of totality frames        }
{                  z = (d2 + d3)/2                                   }
{                  p = d2 / 2                                        }
{                  a = t - s - z                                     }
{                  x = (a - A) / n                                   }
{                                                                    }
{            PROCEDURES Detailed Here Are...                         }
{               initialize                                           }
{               normalize                                            }
{                       COMPLETED 12/16/79                           }
{}
{     Step 3: Fill in the simulated details...                       }
{           Create a program which uses the results of step 3 to     }
{       go through a detailed time line of the experiment on paper   }
{       (or terminal screen).  Each event (shutter transition        }
{       open-->close or close-->open will be marked by a report of   }
{       its nature and time of execution relative to <start> signal  }
{                                                                    }
{            PROCEDURES Detailed Here Are...                         }
{               await_cue                                            }
{               diamond_ring_burst                                   }
{               totality                                             }
{}
{     Step 4: Adapt to real time control -                           }
{          Put in augmentations of the software to actually demon-   }
{       strate operation with the NiKon F2A camera via a relay       }
{       plugged into the Apple II Game Paddle Socket                 }
{       THIS IS THE FINAL FORM OF THE PROGRAM TO BE USED IN THE      }
{       FIELD CONTROLLING THE EXPERIMENT...                          }
{          Necessary step: determining a method of measuring time    }
{       intervals from the CPU clock which is consistent with UCSD   }
{       Pascal.  Possibly use assembly language subroutine.          }
{}


PROGRAM eclipse_monitor_simulation;


   CONST
      minimum_pulse_width = 20 {milliseconds};
      overhead_duration = 210 {milliseconds};
      open_shutter_address  = -16295 {sets AN0 output to "1"};
      close_shutter_address = -16296 {resets AN0 output to "0"};
      post_ring_delay = 500 {milliseconds};

   TYPE
      seconds      = INTEGER;
      milliseconds = INTEGER;
      absolute_time =
         RECORD
```

Listing 1 continued on page 58

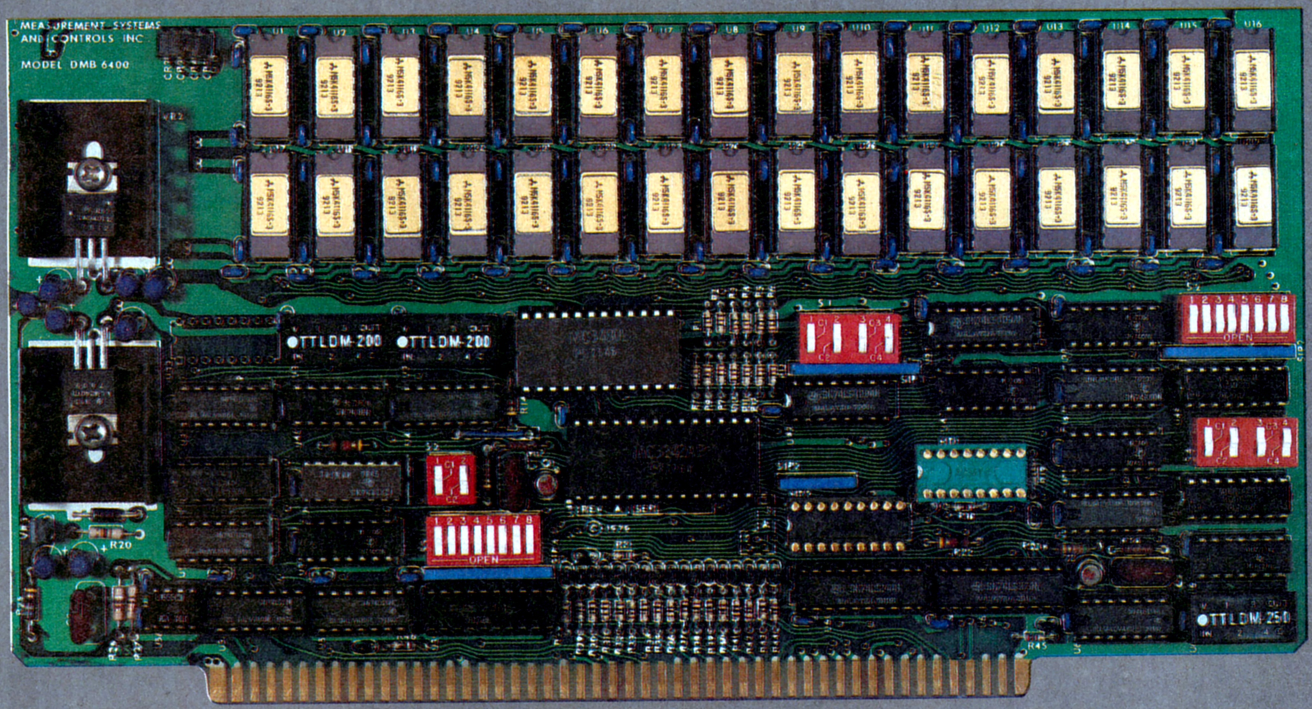
fired up the generator to supply power. We then set up our respective Apples. We naively thought that final programming details could be accomplished that day sitting in the tropical sun. But our preparations had neglected to include a canopy or sun shade. Norm's Apple worked quite well in the heat, perhaps because he had rigged up a sort of sun shade using his towel, two camera tripods, and a large piece of gaily colored cloth.

My Apple, however, had been baking in its carrying case all morning before I set it up. Its integrated circuits were hot to touch even before I turned it on. I turned it on and Pascal booted as usual. I entered my eclipse program and proceded to check it out. But after one or two allocation runs, the operation of the program was rather unusual and erratic. As often happens in such situations, I cycled the power switch in order to reboot the system's software. With this, the system simply refused to operate in a normal fashion! After leaving the system off for about 2 minutes, I was again able to get it started. But it crashed again more quickly.

My conclusion was that the direct sunlight was baking my computer, giving it the electronic equivalent of the sunburn I was so carefully avoiding for myself. It seems that Apples do not work too well when temperatures are elevated to the point where components are too hot to touch. I estimate that the surface temperature of the main board at this time was in the range of 150° to 180°Fahrenheit (66° to 82° Celsius). Noting the excessive heat, I just turned off the system and thought about strategies for keeping it cool and out of sunlight until the eclipse happened. That evening after sunset and before the nightly parade of hippos began, I verified that the computer was still functional.

As it turns out, heat was not a problem the next day, February 16, 1980. The day of the eclipse broke with a solid overcast, not an auspicious beginning. If first contact were to have occurred at 8:30 in the

Text continued on page 66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Listing 1 continued:

```
            units       : seconds;
            thousandths : milliseconds
         END;
      exposures     = INTEGER;
      an_exposure_detail =
         RECORD
            duration    : milliseconds;
            wait_after  : milliseconds
         END;
      string_pointer = ↑STRING;


   VAR
      s                  : STRING[128];
      crash_ahead        : BOOLEAN;

      an_integer        : INTEGER;

      x,n                : INTEGER;
      sigma              : INTEGER;
      which_ring         : (second,third);

      a,b,c               : absolute_time;
      ring_time           : absolute_time;
      second_contact_ring : absolute_time;
      third_contact_ring  : absolute_time;
      tot_time            : absolute_time;
      time_totality       : absolute_time;
      margin_time         : absolute_time;
      current_time        : absolute_time;
      half_time           : absolute_time;
      quarter_time        : absolute_time;
      slack_in_totality   : absolute_time;
      dummy               : absolute_time;
      total_elapsed_time  : absolute_time;
      total_duration      : absolute_time;

      maximum            : exposures;
      total_eclipse      : exposures;
      ring_frames        : exposures;
      current_shot       : exposures;

      twenty_five_shots : PACKED ARRAY[0..24] OF an_exposure_detail;
      transient_shots   : PACKED ARRAY[0..1] OF an_exposure_detail;

<<<< opening "EUTILS.TEXT>>>>

{   Miscellaneous routines used throughout the program }
{      ---> new_page             }
{      ---> set_parameter        }
{      ---> error_abort          }
{      ---> subtract_time        }
{      ---> divide_time          }
{      ---> add_time             }
{      ---> print_time           }
{      --->                      }
{      --->                      }
{      --->                      }
{      --->                      }
{      --->                      }



   PROCEDURE new_page;
      VAR
         stuff : STRING[24];
         clear_screen : CHAR;
      BEGIN
         stuff := '                        ';
         clear_screen := CHR(24);
         WRITELN(clear_screen,stuff);
         WRITELN(' ');
         WRITELN(' ');
         WRITELN(s)
      END {new_page};

   PROCEDURE set_parameter(VAR time : absolute_time);
      VAR
         a_string : STRING[128];
         i : INTEGER;
         period : BOOLEAN;
         decimal_count : INTEGER;
         factor, result : INTEGER;

         PROCEDURE add_a_digit(position : INTEGER);
            VAR
               digit : INTEGER;
            BEGIN
               digit := (ORD(a_string[position])-ORD('0'));
               IF period THEN
                  BEGIN
```

Listing 1 continued on page 60

Circle 30 on inquiry card. →

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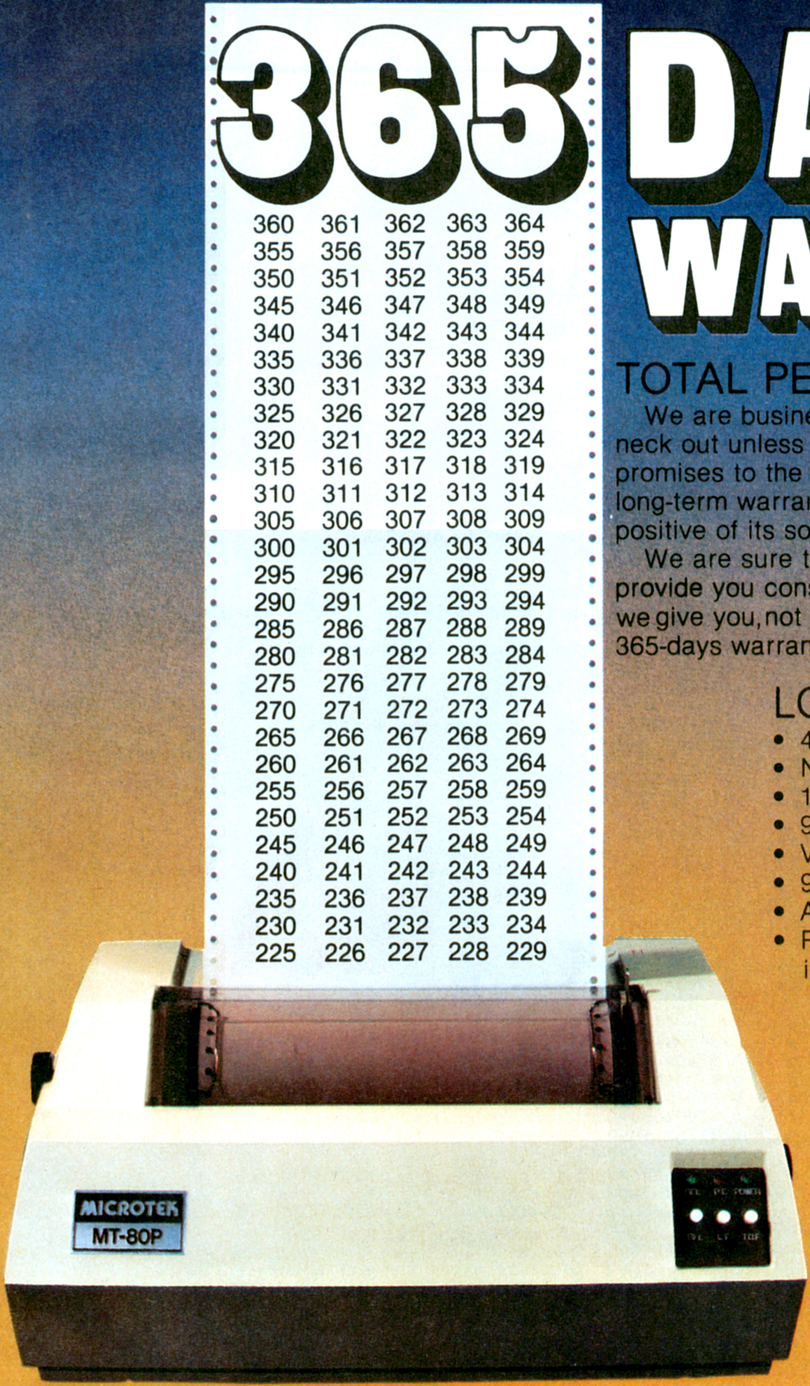
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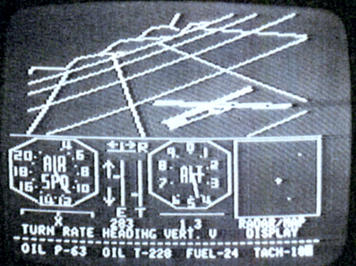

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Listing 1 continued:

```
                     decimal_count := decimal_count + 1;
                     IF decimal_count < 4 THEN
                        BEGIN
                           time.thousandths := time.thousandths
                                 + ((1000 * digit) DIV factor );
                           factor := 10 * factor
                        END
                  END
               ELSE (before period)
                  time.units := (time.units * factor ) + digit
            END;

      BEGIN (set_parameter)

      PAGE( OUTPUT );
      time.units := 0;
      time.thousandths := 0;
      WHILE ((time.units=0) AND (time.thousandths=0)) DO
         BEGIN
            factor := 10;
            decimal_count := 0;
            period := FALSE;
            WRITELN( s );
            READLN( a_string );
            FOR i := 1 TO LENGTH( a_string ) DO
               BEGIN
                  CASE a_string[i] OF
                     '0','1','2','3','4','5','6','7','8','9':
                        add_a_digit( i );
                     '.':
                        period := TRUE
                  END
               END
         END (WHILE)
   END (set_parameter);

PROCEDURE error_abort;
   BEGIN
      maximum := 250;
      total_eclipse := 200;
      ring_frames := 25;
      WRITELN( 'Unrecoverable error in data' );
      crash_ahead := FALSE
   END;

PROCEDURE subtract_time( a,b : absolute_time; VAR c : absolute_time );
   BEGIN
      c.thousandths := a.thousandths - b.thousandths;
      sigma := 0;
      IF c.thousandths < 0 THEN
         BEGIN
            c.thousandths := c.thousandths + 1000;
            sigma := -1
         END;
      c.units   := a.units   - b.units   + sigma
   END;

PROCEDURE divide_time(
                      VAR a : absolute_time;
                      b : absolute_time;
                      n : INTEGER
                     );
   ( a <-- b DIV n )
   VAR
      p,q : INTEGER[16];
   BEGIN
      a.thousandths := 0;
      a.units := 0;
      q := b.units;
      q := q * 1000;
      q := q + b.thousandths;
      q := q DIV n;
      p := q DIV 1000;
      IF p < 32768 THEN
         a.units := TRUNC( p );
      p := q - (1000 * p);
      IF p < 32768 THEN
         a.thousandths := TRUNC( p )
   END;

PROCEDURE add_time( a,b : absolute_time; VAR c : absolute_time );
   BEGIN
      sigma := a.thousandths + b.thousandths;
      c.thousandths := sigma MOD 1000;
      c.units   := a.units   + b.units   + (sigma DIV 1000)
   END;

PROCEDURE print_time( a : absolute_time );
   VAR
      z1000,z100 : STRING[1];
   BEGIN
      IF a.thousandths < 100 THEN z1000 := '0' ELSE z1000 := '';
      IF a.thousandths < 10 THEN z100 := '0' ELSE z100 := '';
      IF LENGTH( s ) > 25 THEN s := COPY( s,1,25 );
      WRITELN( s,a.units,'.',z1000,z100,a.thousandths )
```

Listing 1 continued on page 62

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Listing 1 continued:

```
      END;
<<<< opening "ENORMAL.TEXT>>>>

PROCEDURE normalize_timing;
   VAR
      i                  : INTEGER;

   PROCEDURE sum_up_ring(ring: INTEGER; VAR ring_total : absolute_time);
      VAR
         index,i : INTEGER;
         this_ring : absolute_time;

      BEGIN
         ring_total.units        := 0;
         ring_total.thousandths := post_ring_delay;
         FOR i := 1 TO ring_frames  DO
            BEGIN
               this_ring.units := 0;
               this_ring.thousandths := transient_shots[ring].wait_after;
               add_time( this_ring,ring_total,ring_total);
               this_ring.thousandths := transient_shots[ring].duration;
               add_time( this_ring,ring_total,ring_total)
            END
      END;

   PROCEDURE sum_up_eclipse( VAR eclipse_total : absolute_time);
      VAR
         this_shot : absolute_time;
         index,i,j : INTEGER;
      BEGIN
         eclipse_total.units := 0;
         eclipse_total.thousandths := overhead_duration;
         { this compensates for the minimum wait after one      }
         { frame started and ended during the slack time period}
         FOR i := 1 TO total_eclipse DO
            BEGIN
               this_shot.units := 0;
               index := (i-1) MOD 25;
               this_shot.thousandths := twenty_five_shots[index].wait_after;
               add_time( this_shot,eclipse_total,eclipse_total);
               this_shot.thousandths := twenty_five_shots[index].duration;
               add_time( this_shot,eclipse_total,eclipse_total)
            END
      END;

PROCEDURE preliminary_allocation;
   BEGIN
      s := 'Allocation of Eclipse Times...';
      new_page;
      s := 'Total time of eclipse   = ';
      print_time( time_totality);

      WRITELN( '-----------------------------------------' );
      which_ring := second;
      sum_up_ring( ORD( which_ring ),second_contact_ring);

      s := 'Second contact time     = ';
      print_time( second_contact_ring);

      which_ring := third;
      sum_up_ring( ORD( which_ring ),third_contact_ring);

      s := 'Third contact time      = ';
      print_time( third_contact_ring);

      add_time( second_contact_ring,third_contact_ring,ring_time);
      s := 'Tot. diamond ring time = ';
      print_time( ring_time);
      divide_time( quarter_time,second_contact_ring,2);
      s := 'Anticipation time       = ';
      print_time( quarter_time);


      WRITELN( '-----------------------------------------' );
      sum_up_eclipse( tot_time);
      s := 'Totality time           = ';
      print_time( tot_time);
      s := 'Margin at end totality = ';
      print_time( slack_in_totality);

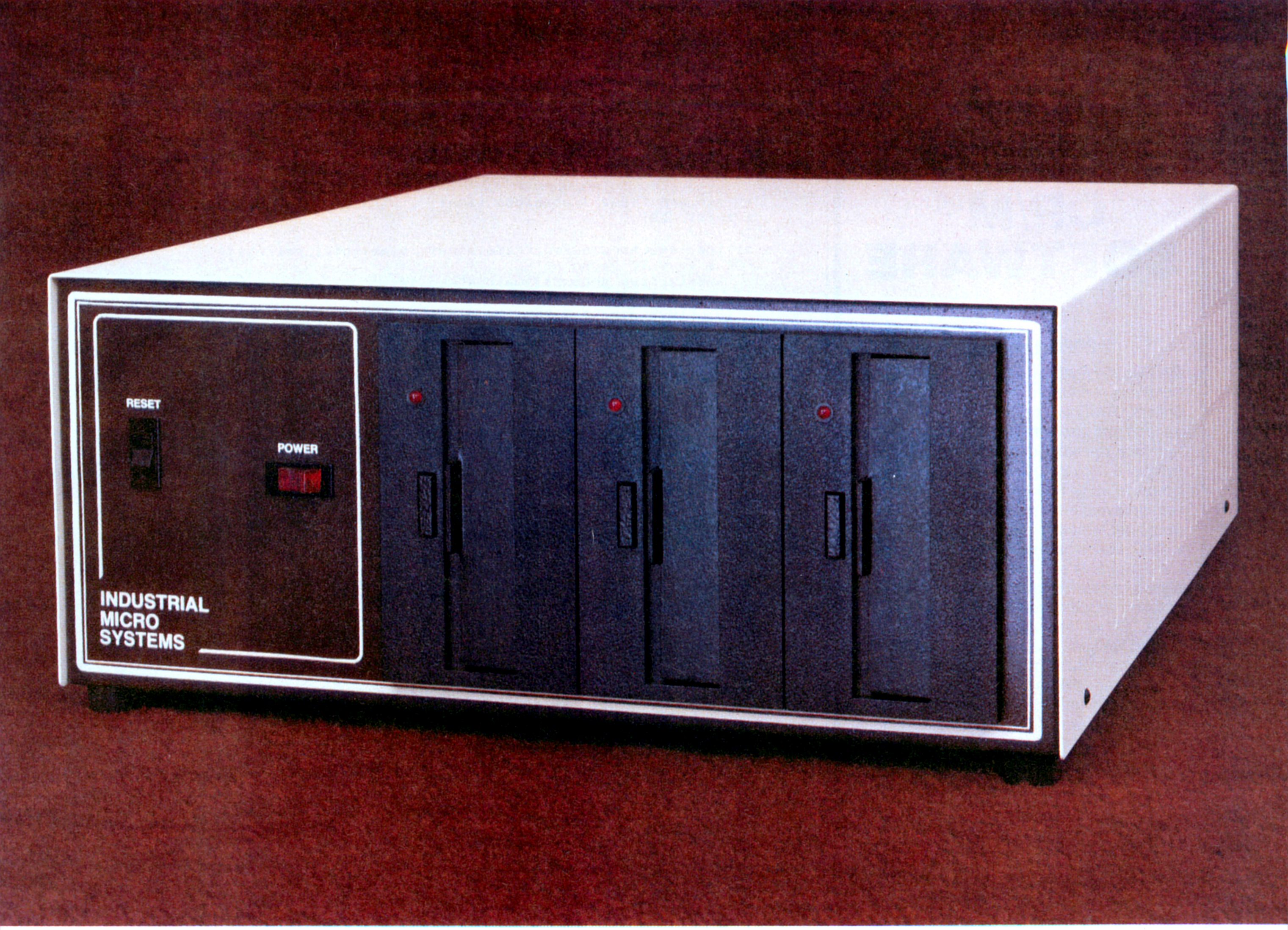
      divide_time( half_time,ring_time,2);
      s := 'Diamond ring slack      = ';
      print_time( half_time);

      add_time( tot_time,slack_in_totality,total_duration);
      add_time( total_duration,half_time,total_duration);
      s := 'Total time initially    = ';
      print_time( total_duration);

      WRITELN( '-----------------------------------------------------------' );
      subtract_time( time_totality,total_duration,margin_time);
      s := 'Margin for allocation   = ';
      print_time( margin_time)
   END {preliminary_allocation};
```

Listing 1 continued on page 64

Circle 34 on inquiry card. →



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ISIS[1] to CP/M® conversion utilities permit CP/M® users to read or write files to or from an ISIS[1] diskette. The package consists of three utility programs that *read, write* and display the ISIS[1] *directory*.

ISIS[1] - CP/M® Utilities	**$125**
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'FPP' is a set of 8080 assembly language subroutines that provide 12 digit BCD arithmetic functions for *add, subtract, multiply,* and *divide*. BCD arithmetic means no conversion errors and minimal conversion time. Source code is supplied on standard 8" diskette.

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[1] ISIS is a trademark of Intel Corporation.
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Listing 1 continued:

```
PROCEDURE margin_dispersal;
   VAR
      margin_per_frame : absolute_time;
      i : INTEGER;
   BEGIN
      divide_time( margin_per_frame,margin_time,total_eclipse );
      FOR i := 0 TO 24 DO
         twenty_five_shots[i].wait_after :=
            twenty_five_shots[i].wait_after +
            (1000 * margin_per_frame.units ) +
            margin_per_frame.thousandths;
      s := 'Margin per tot. frame  = ';
      print_time( margin_per_frame )
   END {margin_dispersal};

PROCEDURE final_allocation;
   BEGIN
      sum_up_eclipse( tot_time );
      s := 'Adjusted total phase    = ';
      print_time( tot_time );

      add_time( tot_time,slack_in_totality,total_duration );
      add_time( total_duration,half_time,total_duration );
      s := 'Adjusted commitments    = ';
      print_time( total_duration );

      add_time( tot_time,slack_in_totality,total_elapsed_time );
      add_time( total_elapsed_time,ring_time,total_elapsed_time );
      s := 'Total elapsed time      = ';
      print_time( total_elapsed_time );

      WRITELN( '--------------------------------------------------------' );
      subtract_time( time_totality,total_duration,margin_time );
      s := 'Margin after allocation= ';
      print_time( margin_time )
   END {final_allocation};

PROCEDURE alloc_exposures;
   BEGIN
      ring_frames :=
         (maximum - total_eclipse) DIV 2;
      IF ring_frames < 2 THEN error_abort;
      sigma := maximum - (total_eclipse + (2 * ring_frames));
      total_eclipse := total_eclipse + sigma;
      WRITELN( '' );
      WRITELN( '      Exposures map:' );
      WRITELN( 'First diamond ring  = ',ring_frames );
      WRITELN( 'Totality            = ',total_eclipse );
      WRITELN( 'Second diamond ring = ',ring_frames );
      WRITELN( '                        --------' );
      WRITELN( '      TOTAL           = ',maximum );
      WRITELN( '' );
      WRITELN( '' );
      WRITELN( 'Press return to continue' );
      READLN( s )
   END {alloc_exposures};

  BEGIN {normalize_timing}

     alloc_exposures;

     preliminary_allocation;

     margin_dispersal;

     final_allocation

  END {normalize_timing};

PROCEDURE milli( time : INTEGER );
   EXTERNAL;

PROCEDURE ref_memory( address : INTEGER );
   { This procedure uses the variant record technique to
     reference an address passed to it as a 16 bit signed
     INTEGER.  The Apple-II hardware will set or reset the
     annunciator outputs of the Game I/O connector if the
     appropriate addresses are simply referenced by a program.
   }

   TYPE
      ptr = ↑CHAR;

      memory_access = (pointer,number )
      {this is a dummy statement required by the syntax of
         Pascal variant records such as "memory" below. The
         variant record "trick" is not the most elegant way
         to reference an absolute hardware address, since it
         requires an implementation-dependent assumption about
         variant records, ie: that a 16 bit signed two's complement
         INTEGER type maps bit for bit into the 16 bit positive
         integer value of an address stored in a Pascal pointer
         data type.
      };
```

Listing 1 continued on page 66

Circle 36 on inquiry card. →

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Text continued from page 56:

morning as was the case in Montana last year, we would have missed the eclipse. But by the time of first contact, about 10 AM, the clouds had dissipated somewhat in the hot sun, to the point where maybe 50% of the time the sun was obscured. What this early cloudiness did, however, was keep my Apple from getting too hot too soon.

As the eclipse progressed, the air cooled off. Whether this lack of insolation due to the early phases of the eclipse affected the weather or not, it certainly helped guarantee the performance of my Apple during the total phase of the eclipse. At 11 AM when I turned on the power to my computer, it was delightfully cool in comparison with the previous afternoon. The weather had also improved considerably. We seemed by this time to be in a beautiful bowl of clear blue sky with the nearest clouds perhaps 5 to 10 miles away. This perfect eclipse-viewing weather lasted until well after the end of the event.

The Pascal system booted properly, and I proceeded to set up the final allocation I would use. Because I wanted to take a few partial phase shots manually, I had decided earlier that morning to limit the shots of totality to 200 exposures, with 120 taken during actual totality and the balance of 80 split equally between the two diamond-ring events. A slack time of 40 seconds was chosen to allow for the extra long exposure toward the end of the eclipse. Just to keep verifying the operation of the computer, I kept reentering the allocation phase of the program every few minutes.

Finally, at 11:21 AM, totality was heralded by a beautiful set of "shadow bands." After watching these last glimmers of direct sun, I removed the filter from my camera and gave the first manual cue to my eclipse program. I then had four enjoyable minutes of direct viewing of the eclipse, its effects on the local animal life, a glimpse of sunlight still illuminating the upper part of Kilimanjaro, and the incredible colorations of the distant clouds on the

Listing 1 continued:

```
       memory =
          RECORD
             CASE memory_access OF
                pointer : (a_pointer : ptr);
                number  : (a_number : INTEGER)
          END;

    VAR
       anybyte : memory;
       anychar : CHAR;

    BEGIN
       anybyte.a_number := address;
       anychar := anybyte.a_pointer↑
    END {ref_memory};

PROCEDURE take_picture(photograph : an_exposure_detail);
   BEGIN
      ref_memory(open_shutter_address);
      milli(photograph.duration);
      ref_memory(close_shutter_address);
      milli(photograph.wait_after)
   END {take_picture};



PROCEDURE initialize;
   VAR
      running_index : INTEGER;
   BEGIN {initialize}
      s := '';
      ref_memory(close_shutter_address);
      current_time.units        := 0;
      current_time.thousandths := 0;
      current_shot := 0;
      twenty_five_shots[0].duration     := 1     + minimum_pulse_width;
      twenty_five_shots[1].duration     := 2     + minimum_pulse_width;
      twenty_five_shots[2].duration     := 5     + minimum_pulse_width;
      twenty_five_shots[3].duration     := 10    + minimum_pulse_width;
      twenty_five_shots[4].duration     := 20    + minimum_pulse_width;
      twenty_five_shots[5].duration     := 50    + minimum_pulse_width;
      twenty_five_shots[6].duration     := 100   + minimum_pulse_width;
      twenty_five_shots[7].duration     := 200   + minimum_pulse_width;
      twenty_five_shots[8].duration     := 500   + minimum_pulse_width;
      twenty_five_shots[9].duration     := 1000  + minimum_pulse_width;
      twenty_five_shots[10].duration    := 2000  + minimum_pulse_width;
      twenty_five_shots[11].duration    := 5000  + minimum_pulse_width;
      twenty_five_shots[12].duration    := 10000 + minimum_pulse_width;
      twenty_five_shots[13].duration    := 5000  + minimum_pulse_width;
      twenty_five_shots[14].duration    := 2000  + minimum_pulse_width;
      twenty_five_shots[15].duration    := 1000  + minimum_pulse_width;
      twenty_five_shots[16].duration    := 500   + minimum_pulse_width;
      twenty_five_shots[17].duration    := 200   + minimum_pulse_width;
      twenty_five_shots[18].duration    := 100   + minimum_pulse_width;
      twenty_five_shots[19].duration    := 50    + minimum_pulse_width;
      twenty_five_shots[20].duration    := 20    + minimum_pulse_width;
      twenty_five_shots[21].duration    := 10    + minimum_pulse_width;
      twenty_five_shots[22].duration    := 5     + minimum_pulse_width;
      twenty_five_shots[23].duration    := 2     + minimum_pulse_width;
      twenty_five_shots[24].duration    := 1     + minimum_pulse_width;
      FOR running_index := 0 TO 24 DO
         twenty_five_shots[running_index].wait_after   := overhead_duration;

      transient_shots[0].duration    := 5        + minimum_pulse_width;
      transient_shots[1].duration    := 50       + minimum_pulse_width;
      FOR running_index := 0 TO 1 DO
         transient_shots[running_index].wait_after   := overhead_duration;

      s := 'Restarting the program';
      new_page;
      WRITELN('Enter 0 to end, 1 to continue');
      WRITELN('    then <return>        ');
      READLN(an_integer);


      IF an_integer > 0 THEN
         BEGIN
            s := 'Preliminary data initialization';
            new_page;
            s := '    Enter number of exposures';
            set_parameter(dummy);
            maximum := dummy.units;
            s := 'Enter exposures in totality';
            REPEAT
               BEGIN
                  set_parameter(dummy);
                  total_eclipse := dummy.units
               END
```

Listing 1 continued on page 68

Circle 37 on inquiry card. ➞

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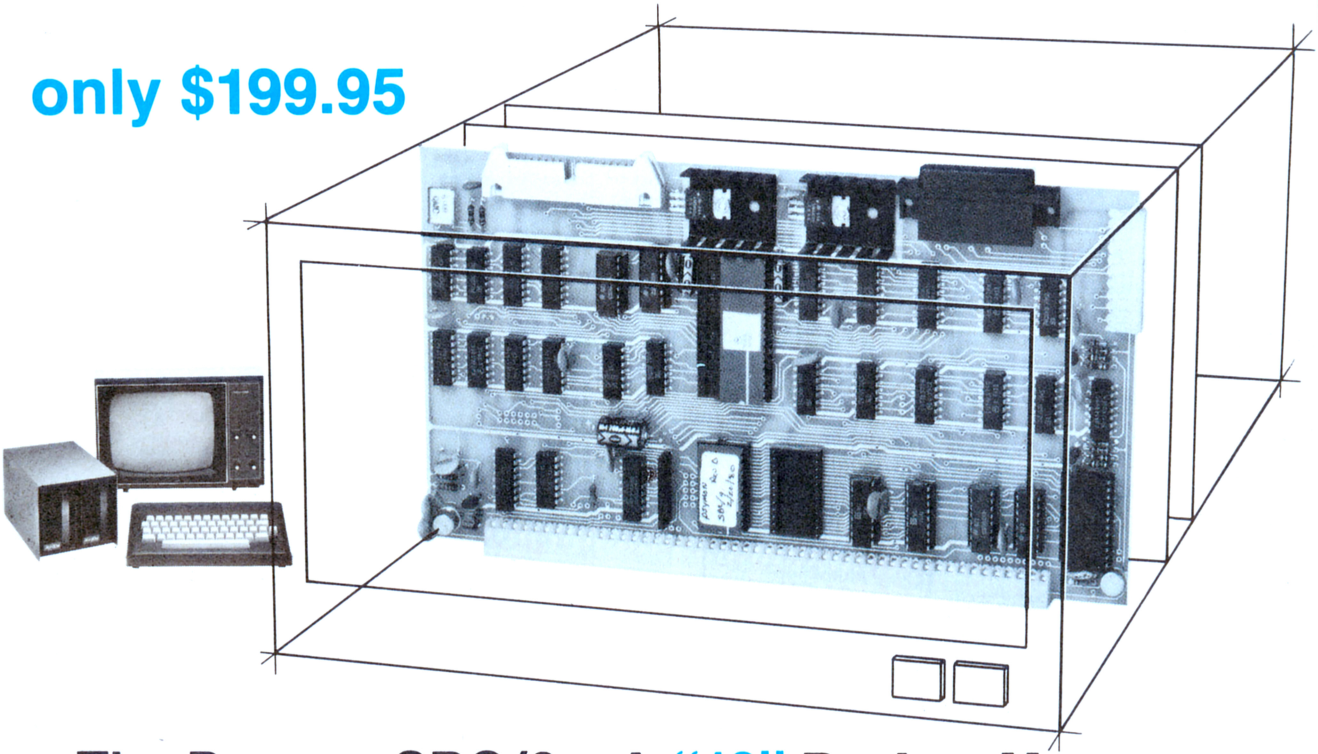

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horizon. I used a second camera with a wide-angle lens to take several hand-held pictures. Eventually the moment passed as Norm announced the coming of third contact as predicted by his computer program running in conjunction with a Mountain Hardware real-time clock. Perhaps a bit too late, I gave my second manual cue to my program, and I prepared to apply the lens cap to protect the camera and optics.

The rest of the trip was, of course, anticlimactic. I had the satisfaction of having had my program work as planned, the good fortune of avoiding a repeat of the thermal problems of the day before the eclipse, and the knowledge that a significant improvement in eclipse viewing can be achieved using a computer system. We returned home the next Thursday, and by Friday noon I was able to view the images photographed by my system during those 4 minutes in Tsavo the Saturday before. I don't know when I will next see a solar eclipse, but I am sure that whatever the state of the art of microcomputers at the time, I will be using one to improve my automation of photography of the 1980 eclipse.

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Listing 1 continued:

```
            UNTIL
               (total_eclipse > 0)
                              AND
               (total_eclipse < maximum);
            s := 'Enter totality duration (sec)';
            get_parameter(time_totality);
            s := 'Enter slack time (sec)';
            get_parameter(slack_in_totality)
         END;
      crash_ahead := TRUE
   END {initialize};

PROCEDURE await_cue;
   VAR
      anychar : PACKED ARRAY[0..0] OF CHAR;
   BEGIN {await_cue}
      WRITELN('' );
      WRITELN('' );
      WRITELN('' );
      WRITELN('**********************' );
      WRITELN('Awaiting manual cue' );
      WRITELN('**********************' );
      UNITREAD(2,anychar,1,0,0)
   END {await_cue};

PROCEDURE diamond_ring_burst;
   VAR
      i : INTEGER;
   BEGIN {diamond_ring_burst}
      FOR i := 1 TO ring_frames DO
         BEGIN
            IF which_ring = second THEN
               take_picture(transient_shots[0])
            ELSE
               take_picture(transient_shots[1])
         END;
      milli(post_ring_delay)
   END {diamond_ring_burst};

PROCEDURE totality;
   VAR
      exposure_count : INTEGER;
      cyclic_choice  : INTEGER;
   BEGIN {totality}
      WRITELN('Begin totality sequence' );
      cyclic_choice := 0;
      FOR exposure_count := 1 TO total_eclipse DO
         BEGIN
            take_picture(twenty_five_shots[cyclic_choice]);
            cyclic_choice := (cyclic_choice + 1) MOD 25
         END;
      WRITELN('End totality sequence' )
   END {totality};

PROCEDURE summarize;
   BEGIN {summarize}
      WRITELN('Press return to end program' );
      READLN(s)
   END {summarize};


PROCEDURE perform_eclipse_dance;
   BEGIN
      await_cue;
      diamond_ring_burst;
      totality;
      ref_memory(open_shutter_address); {sneak in one more exposure}
      await_cue;
      ref_memory(close_shutter_address);
      milli(overhead_duration);
      diamond_ring_burst
   END;


BEGIN {eclipse_monitor_simulation}
   an_integer := 100;
   WHILE an_integer > 0 DO
      BEGIN
         initialize;
         IF an_integer > 0 THEN
            BEGIN
               normalize_timing;
               WRITELN('Is this an eclipse run? (Y = yes)' );
               READLN(s);
               IF LENGTH(s) < 1 THEN s := ' ';
               IF ((s[1] = 'y') OR (s[1] = 'Y')) THEN
                  perform_eclipse_dance
            END
      END;
   summarize
END. {eclipse_monitor_simulation}
```

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Critique of Technique

This use of computer automation in photographing a solar eclipse provided a valuable improvement over manual methods. Computer automation allowed me to plan an exposure sequence which would be executed without relatively error-prone manual operations. This goal was achieved in the experiment described here. But by building on experience, one can always improve the techniques.

A relatively simple improvement would be to devote some automation to the partial phases of the eclipse. This would be accomplished by adding a loop to take photographs, for example, every five minutes, listening for the manual cue of imminent totality between partial phase shots. This would also assume cool enough temperatures for reliable operation over a 90-minute time span. I left this feature out because I had no idea of the proper exposure time to use and was too busy getting the main goal accomplished.

The problem of determining the mechanical overhead of the Nikon Motor Drive in the "bulb" position needs further attention. The shortest exposures in the 1980 eclipse were dictated by a fixed overhead time needed to ensure reliable triggering of the motor drive. If this time is too long, given the film used, then two options remain: using a slower film, or applying a filter to the lens during totality. The diamond-ring exposure times were much too long for a good photographic result. This problem would go away if a slower film or filters were applied. Since an equatorial telescope mount was tracking the sun during the eclipse, use of slower film would give a shorter effective minimum exposure time without sacrificing resolution with the long shots.

Two problems with my procedures during the 1980 eclipse will not go away given improvements in computer systems techniques. The first problem is that of inadequate timing cues. While it would be possible to use a real-time clock to coordinate with universal time, such an open-loop operation would not necessarily guarantee better timing of the start of the sequences of totality photographs due to imprecision in our knowledge of latitude and longitude at a remote site.

The second difficult problem is forgetting to verify focusing of the camera during the automatic sequence. In this eclipse, I was lucky, because I did not jar the camera while removing the filter. But, quite frankly, I forgot to even look through the viewfinder while the automatic programming sequence was in operation. Had I twisted the barrel of the lens while removing the filter I could have had a real disaster of unfocused results.

And of course, the next time I go to the tropics with a computer, a sun shade of some sort will accompany me.

High-Level Conference

A key part of the success of this application of a personal computer to eclipse photography was the use of a high-level language system for nearly all of the programming. Listing 1 shows the final version of the eclipse camera-control program with an additional month's development from the state shown in listing 1 of the March 1980 editorial. This very successful use of Pascal in a relatively sophisticated engineering application helps emphasize the importance of the high-level-language design approach.

The importance of high-level languages in design extends far beyond any particular application. To help provide our professionally oriented readers with an intensive exposure to the design philosophy of modern software tools for small computers, we have created a seminar on the subject. The seminar is organized in conjunction with the McGraw-Hill Conferences and Seminars group. It will be held at the McGraw-Hill building in New York City, June 16 and 17, 1980. The sessions of "The BYTE Conference on Languages and Tools for Microcomputing" will include six important talks on several essential high-level-language systems concepts for small computers.

Dr Fred Martin of Intermetrics Incorporated will talk about the high-level language-oriented software tools developed for the real-time systems programming of the NASA Space Shuttle flight computers. Dr Peter Grogono, author of Programming in Pascal, *will present the philosophy of Pascal, the predominant block-structured, strongly typed language of contemporary microcomputer usage. Dr Ken Bowles, the driving force behind UCSD Pascal, will provide a fascinating talk entitled "After Pascal, What?" which concerns proposed microcomputer implementations of the US Defense Department's Ada language. John Morse of Digital Equipment Corporation will set Bell Laboratories' C language into a microcomputer context, describing its value as a systems and applications program implementation language. Dr Charles Moore of Forth Incorporated will describe the characteristics of Forth as a programming tool appropriate for small computers. Dr Henry Baker of the University of Rochester will complete this suite of language-oriented tools for microcomputers by presenting information on LISP and its applications. This 2-day intensive conference will end with a panel session in which all the speakers will participate.*

For further information, contact The McGraw-Hill Conference and Exposition Center, 1221 Avenue of the Americas, Rm 3677, New York NY 10020, or see the advertisement in this issue. ■

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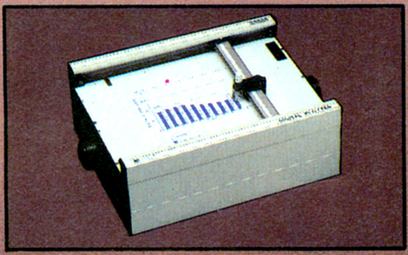

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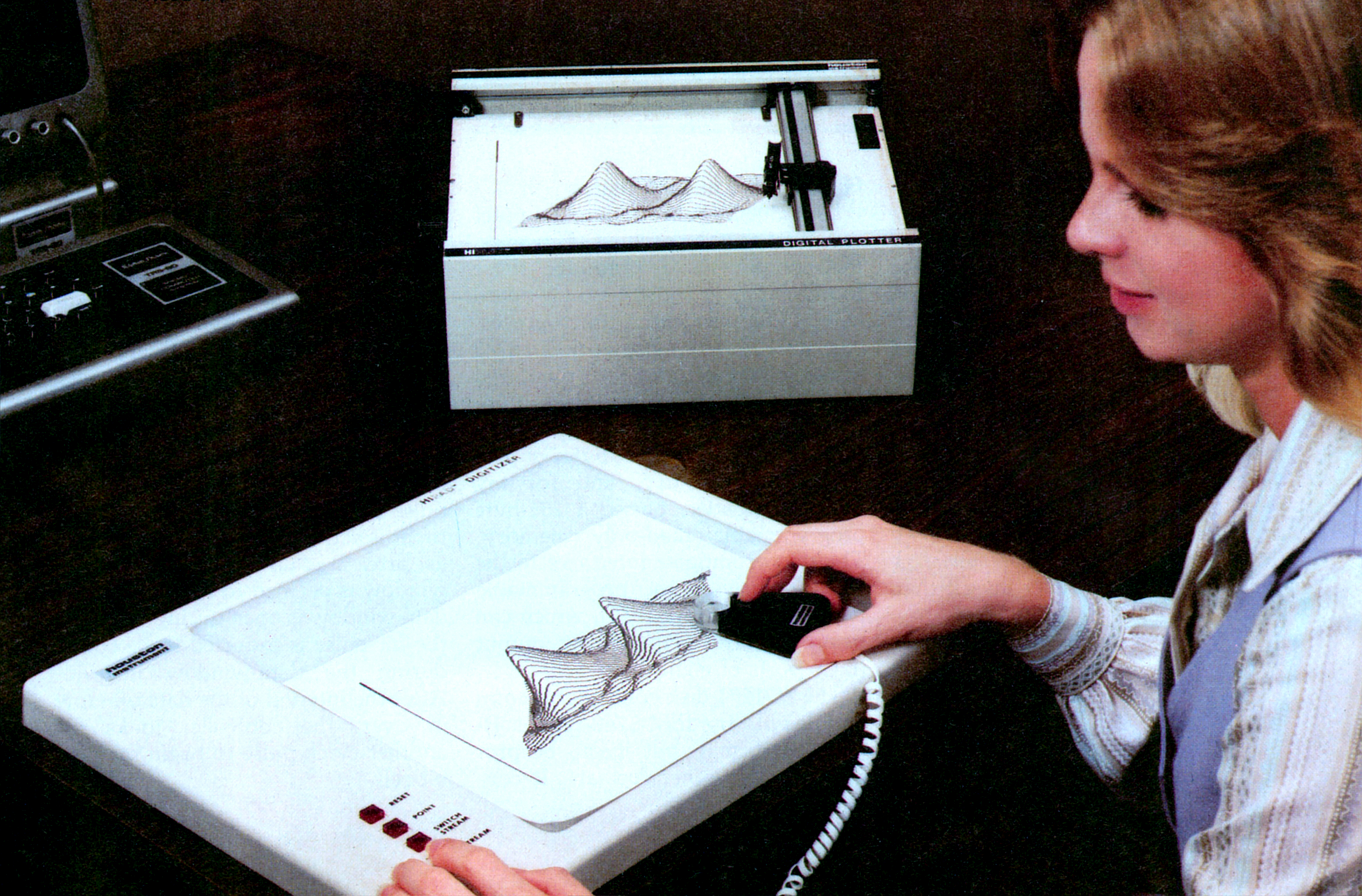

Interface a Floppy-Disk Drive to an 8080A-Based Computer

John Hoeppner
Shugart Associates
415 Oakmead Pky
Sunnyvale CA 94086

The audio cassette has been used by most of us for off-line storage of programs and data. It has two advantages: it is inexpensive, and it is easy to implement because of the wide variety of cassette interfaces available.

However, I grew tired of waiting for the BASIC interpreter and all my data to be loaded every time I powered up my system. Even then, I sometimes had to load and reload the data until the interpreter and my programs were transferred correctly. I decided to try an alternative.

On one hand, the Shugart minifloppy 5-inch disk drive, which costs about $350, was a little more expensive than my cassette recorder; but, on the other hand, the 5-inch floppy disk it uses costs about the same as a quality cassette tape — around $4. And, despite a higher initial investment, the floppy disk is more reliable, and it can transfer programs and data as much as thirty times faster than the audio cassette. It seemed the more programs that were developed, the more worthwhile the additional investment would be. Also, with a recently introduced integrated circuit from Western Digital, the FD1771 floppy-disk formatter/controller, I could design a controller myself that could be interfaced to my 8080A-based microcomputer system.

This article describes the hardware developed to connect a Shugart floppy-disk drive to an 8080A-based system using the Western Digital FD1771 chip, as well as the software routine necessary to drive the FD1771.

Minifloppy is a registered trademark of Shugart Associates used to describe their 5-inch floppy-disk drives.

> The FD1771 disk formatter/controller device is compatible with the IBM 3740 format.

Hardware Characteristics

The 8080A-based microcomputer was one that I designed. However, the components I used are those found on most 8080A single-board computers: an 8080A microprocessor, an 8224 two-phase clock, an 8228 system controller and bus driver, and an 8255 programmable peripheral interface. (See figure 1.) For temporary data storage, I used 2 K bytes of programmable memory, and for my bootstrap loader, I used a 256-byte programmable read-only memory. The microcomputer interfaces to the FD1771 through the programmable peripheral interface (PPI), which can be programmed as three input/output (I/O) ports of eight lines each.

The FD1771 disk controller is compatible with the IBM 3740-type, soft-sectored format, but it can be programmed for other formats. It contains five registers: data, command, sector, track, and status. These registers hold the data and commands transferred from the 8080A processor. The FD1771 has a cyclic redundancy check (CRC) generator for performing a validity check on data transfers. It is also equipped with an internal data separator for separating clock and data bits from the disk into two separate streams. I chose not to use the internal data separator for the following reason.

Each bit of data on the disk is stored during a time interval called a *bit cell*. The bit cell is the space between two of the clock pulses that are recorded on the disk; the beginning of the bit cell is defined by the clock pulse. If the bit is to be recorded as a 1, a pulse is written in the center of the bit cell. If the bit is to be recorded as a 0, no pulse is written in the cell.

The bit pulse must be written on the disk inside certain boundaries. When the pulse is read by the disk drive, the pulse is presented to the controller within a certain time frame called the *data window*. The length of the bit cell is 8 μs. When the clock pulse is detected by the controller, a timer is activated. This timer counts 2 μs; after 2 μs have elapsed, the data window is deemed to be "open." The data window is open during 4 μs, and the bit pulse is expected to be found during the data-window interval. After the interval of the data window in over, the controller looks for another clock pulse to begin the next bit cell.

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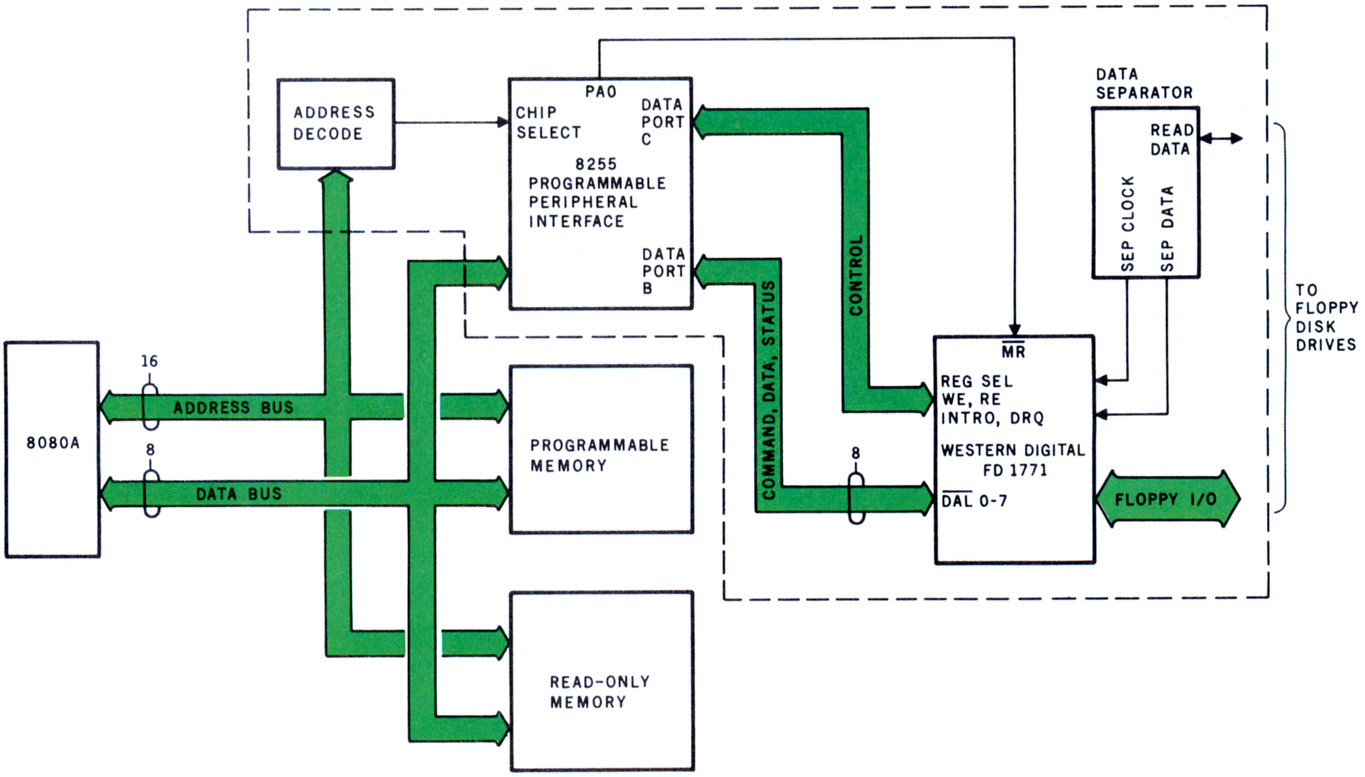

Figure 1: *Block diagram of 8080A-based computer and interface to Shugart SA400 floppy-disk drive. The Western Digital FD1771 disk-controller circuit is illustrated here as the area within the dotted lines.*

The problem with the FD1771 internal data separator arises from the counting after the clock pulse to find the beginning of the data window. The counter in the FD1771 is synchronous with the system clock pulses (at 1 MHz) that are fed into the FD1771. However, the pulses from the disk arrive at the controller *asynchronously*; the variation in the arrival intervals of the pulses is caused by a host of factors. Therefore, the data window as determined by the FD1771 can occupy varying positions within the bit cell. The position may vary by as much as 1 μs (ie: 1 clock cycle) within the 8 μs bit-cell interval.

In worst-case data patterns, this problem may lead to errors and loss of data. Therefore, I provided a data separator of my own design to replace the internal data separator of the FD1771. My data separator was built using a number of discrete logic gates of the 7400 family, as presented in figure 2.

The 5-inch floppy-disk drive I used was a Shugart SA400 minifloppy drive. It is organized to store data in thirty-five independent tracks. Each track contains 3125 unformatted bytes for a total unformatted capacity of 109.4 K bytes per disk. The formatting method I used results in an actual capacity of 71.68 K bytes per disk. The track-to-track access time of the data-transfer (ie: read/write) head is 40 ms. Once the read/write head is positioned above the correct track, another 10 ms of settling time must be allowed before a read or write operation can be performed. The basic data-transfer rate of the drive is 125 K bits per second, which translates to 15.6 K bytes per second. This compares to the audio cassette recorder's transfer rate of about 500 bytes per second.

Connecting the 8255 PPI

The 8255 programmable peripheral interface provides a universal means of interfacing peripheral devices to the 8080 microprocessor. It interfaces to the data bus through the 8228 system controller and bus driver. Three address lines (A0, A1, and A15) of the 8080A are connected to the 8255. Line A15 is connected to the chip select ($\overline{CS}$) line of the 8255, giving the PPI a memory address of hexadecimal 8000. Lines A0 and A1 directly access registers in the 8255. This method of I/O addressing is called memory mapping, because it makes certain memory addresses act as registers for communication between the computer and the peripheral device: it was necessary because the conventional I/O instructions were too slow.

The FD1771 interfaces to the processor through eight data lines (PB0 thru PB7) and seven control lines (PA1, PC0, PC1, PC2, PC3, PC6, and PC7), as shown in figure 2 (page 78). Ports A and B of the PPI, each providing eight lines for transfer of data, interface with the data lines of the FD1771. Three lines of port A also connect directly to the disk drive. Port C of the PPI handles the FD1771 control lines. The eighth control line of the FD1771 is not used, so it is tied to ground.

Six of the outputs of the PPI (PA0 thru PA3, PC2, and PC3) are logically inverted. Because the outputs of *all* ports on the 8255 go low when *any* port is commanded to change direction (from input to output, or vice versa), this inversion is necessary to prevent false signals from going to the FD1771, deselecting the drive and turning off the motor.

Due to total system-timing constraints, disk read and write routines must be performed within 56 μs.

Text continued on page 80

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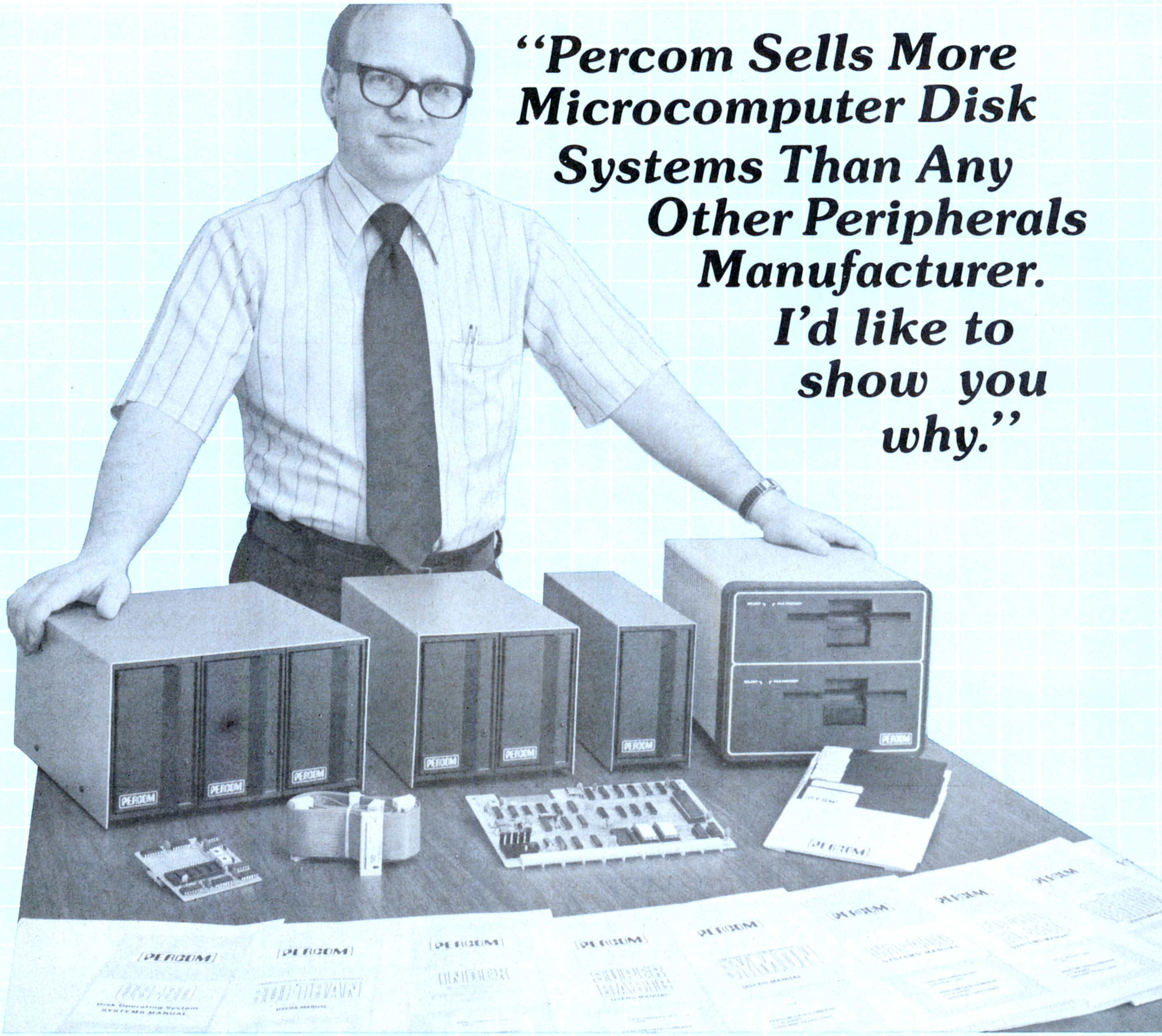

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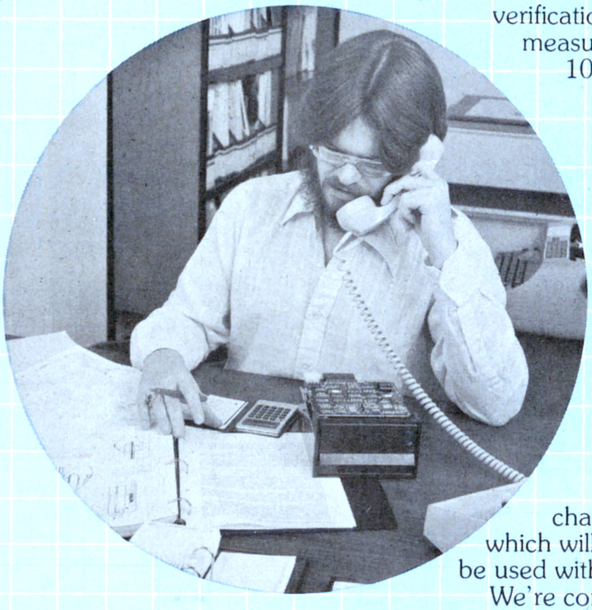

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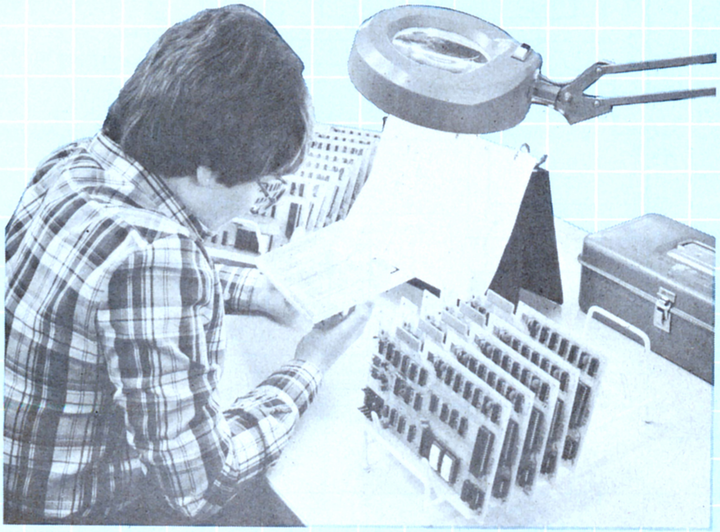

"Slipping a circuit board through the eye of a needle would be easier than slipping a cold solder joint past Beverly. These are four-drive LFD-400/800 disk system controllers she's inspecting."

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Number	Type	+5 V	GND	−5 V	+12 V
IC1	8080A	20	2	11	28
IC2	8228	28	14		
IC3	8255	26	7		
IC4	FD1771	21	20	1	40
IC5	8224	16	8		9
IC6	7404	14	7		
IC7	7404	14	7		
IC8	9602	16	8		
IC9	9602	16	8		
IC10	7414	14	7		
IC11	7414	14	7		
IC12	7438	14	7		
IC13	7438	14	7		
IC14	7474	14	7		
IC15	7474	14	7		
IC16	9602	16	8		
IC17	7400	14	7		
IC18	7400	14	7		
IC19	7404	14	7		

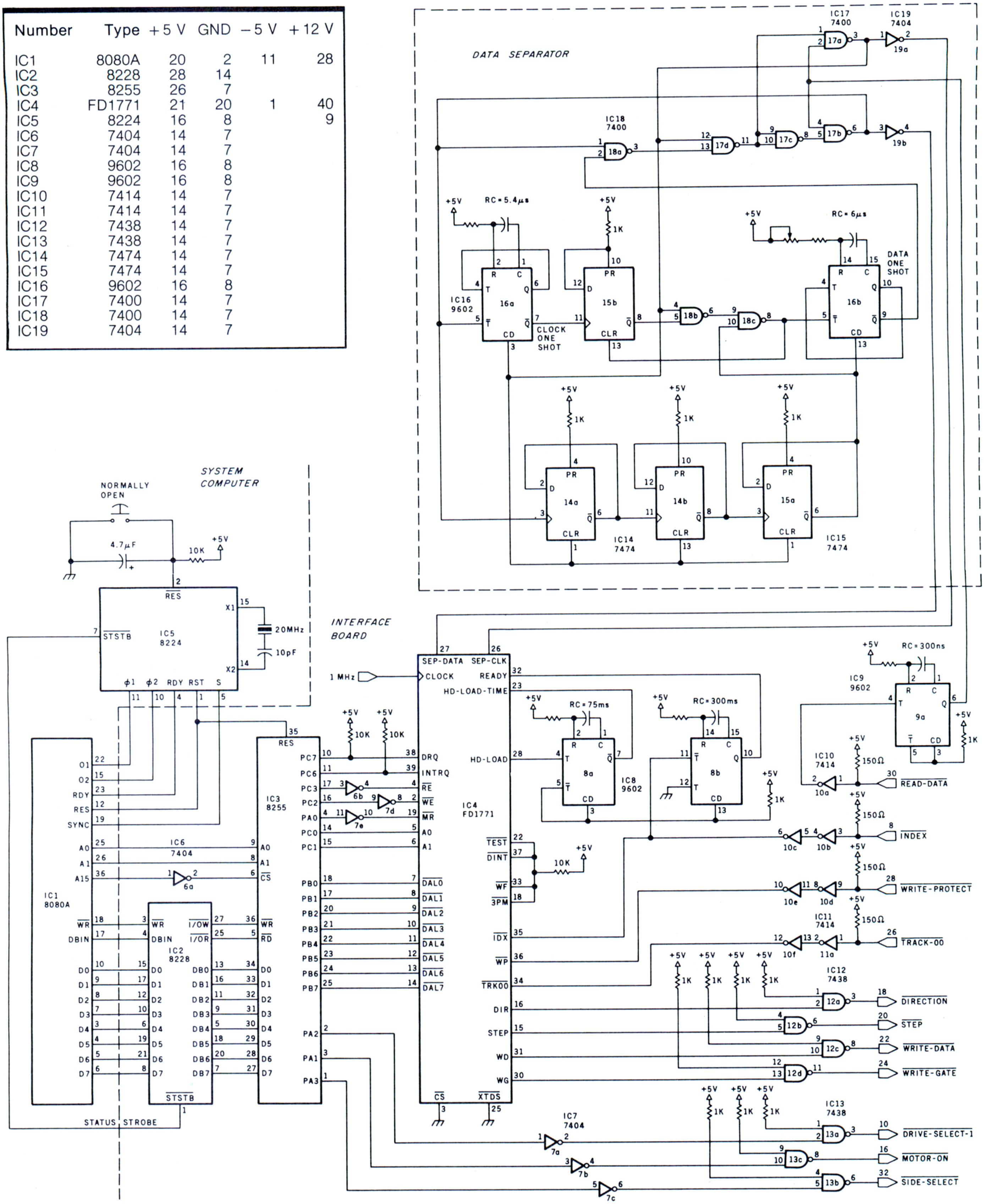
DATA SEPARATOR
IC17 7400
IC19 7404
IC18 7400
RC = 5.4µs
RC = 6µs
IC16 9602
CLOCK ONE SHOT
DATA ONE SHOT
IC14 7474
IC15 7474
SYSTEM COMPUTER
NORMALLY OPEN
4.7µF
10K
+5V
IC5 8224
STSTB
RES
20MHz
10pF
INTERFACE BOARD
1 MHz
IC1 8080A
IC2 8228
IC3 8255
IC4 FD1771
IC6 7404
STATUS STROBE
SEP-DATA
SEP-CLK
CLOCK
READY
HD-LOAD-TIME
HD-LOAD
DRQ
INTRQ
RE
WE
MR
TEST
DINT
IDX
WP
TRK00
DIR
STEP
WD
WG
CS
XTDS
RC = 75ms
RC = 300ms
RC = 300ns
IC8 9602
IC9 9602
IC10 7414
IC11 7414
IC12 7438
IC13 7438
IC7 7404
150Ω
1K
READ-DATA
INDEX
WRITE-PROTECT
TRACK-00
DIRECTION
STEP
WRITE-DATA
WRITE-GATE
DRIVE-SELECT-1
MOTOR-ON
SIDE-SELECT

Figure 2: *Disk-controller board. The circuit to the left of the dotted line is part of the computer being interfaced; the part to the right is the interface to the floppy-disk drive. The area in the dotted box is a data separator made from 7400-series TTL devices. It separates the clock bits from the data bits as they come from the disk drive.*

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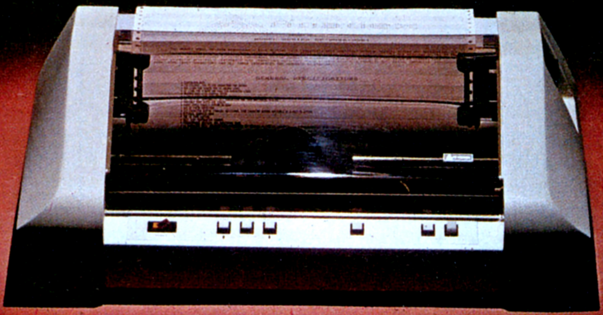

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Text continued from page 74:

Therefore, it was necessary during the design process to shorten the time for checking the status of the drive. To allow fast status checking, bit 7, the most significant bit, of port C is tied to the FD1771's data-request line (DRQ). The value of the DRQ is brought into the accumulator by performing a memory-access instruction. It is then possible to perform an inclusive-OR of the accumulator with itself (ORA A), which results in the sign bit being set to 1 if there is a data request (ie: if DRQ is high). Based on the status of the sign bit, control can branch to the appropriate routine. This arrangement eliminates the need to perform a separate check on the status bits using one of the logical instructions, thereby saving a significant amount of time.

A1	A0	Register Affected During Read ($\overline{RE}=0$, $\overline{WE}=1$)	Register Affected During Write ($\overline{RE}=1$, $\overline{WE}=0$)
0	0	Status Register	Command Register
0	1	Track Register	Track Register
1	0	Sector Register	Sector Register
1	1	Data Register	Data Register

Table 1: *Access to registers within the Western Digital FD1771 disk formatter/controller device. The FD1771 has five internal registers: command, data, sector, status, and track. A given register is read or written by placing the appropriate values on lines A1 and A0 and pulling down either the $\overline{\text{READ-ENABLE}}$ ($\overline{RE}$) line for a read operation, or the $\overline{\text{WRITE-ENABLE}}$ ($\overline{WE}$) line for a write operation. The sector and track registers specify the sector and track when these parameters are needed by a given command byte. The command register, when filled, causes one of eleven high-level instructions to be executed (see table 2). Data passes between the computer and the disk drive through the data register. After a command has been executed by the FD1771, the status register must be read before another command can be executed.*

Interfacing to the SA400

The SA400 drive has connections for twelve transistor-transistor logic (TTL) compatible signal lines. Seven of them connect directly to the FD1771 lines through type-7414 Schmitt-trigger inverters used as line drivers and 7438 open-collector NAND buffers used as line receivers.

The $\overline{\text{WRITE-DATA}}$ line transmits digitized serial data to be written on the floppy disk. The $\overline{\text{WRITE-GATE}}$ signal, when activated, causes the data to be written on the disk. The $\overline{\text{WRITE-PROTECT}}$ line, when active in a low state, indicates that a write-protected disk has been inserted in the drive. The $\overline{\text{STEP}}$ line, when pulsed, causes the read/write head to move radially a distance of one track. The $\overline{\text{DIRECTION-SELECT}}$ line defines the direction that the read/write head moves when the $\overline{\text{STEP}}$ line is pulsed. The $\overline{\text{TRACK-00}}$ line, when low, indicates when the read/write head is positioned over the outermost track, track 0. The $\overline{\text{INDEX}}$ line transmits the pulse that occurs once for every revolution of the floppy disk to indicate the beginning of a track. (The pulse comes when the index hole passes the photodetector.)

Three drive-select lines, which assign the logical drive address, are connected to port A of the 8255 through 7414 and 7438 circuits used as line drivers and receivers. A $\overline{\text{MOTOR-ON}}$ line, also tied to the 8255, controls the spindle-drive motor. The $\overline{\text{READ-DATA}}$ line is tied to the monostable multivibrator (commonly known as a one-shot) that shortens the pulse width from the drive to 300 ns before sending it to the data separator.

The FD1771 has nine other control lines, which control head positioning and data transfers, but which do not interface directly to the disk drive. Four of the lines to the FD1771 are not used. Lines $\overline{\text{TEST}}$, $\overline{\text{DINT}}$, $\overline{\text{WF}}$ and 3PM are therefore tied to +5 V through a 10 k-ohm resistor.

Of the remaining five control lines for the FD1771, the SEPARATED-CLOCK and SEPARATED-DATA lines transmit the clock and data bits from the data separator. (Clock pulses are used in frequency modulated (FM) encoding to signal the beginning of a bit cell.)

The READY line, which signals that the drive is ready for a read or write operation, must be active for the FD1771 to perform any function.

Text continued on page 84

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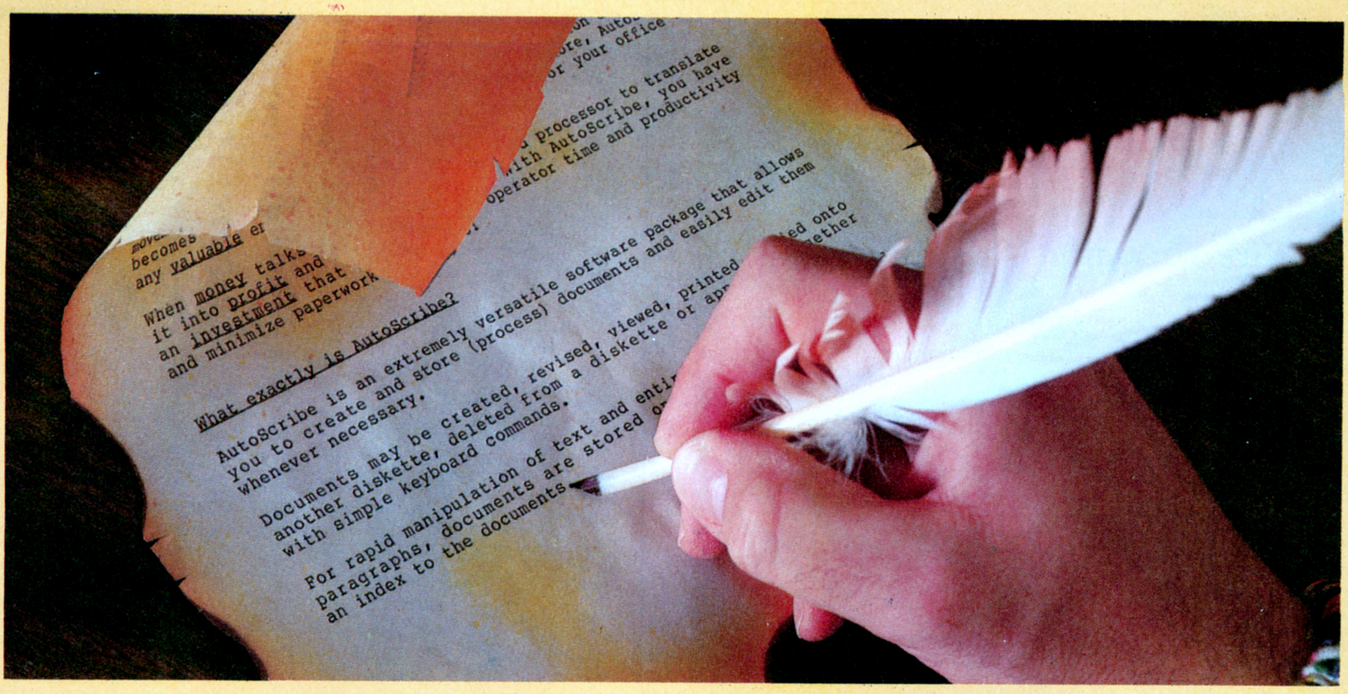
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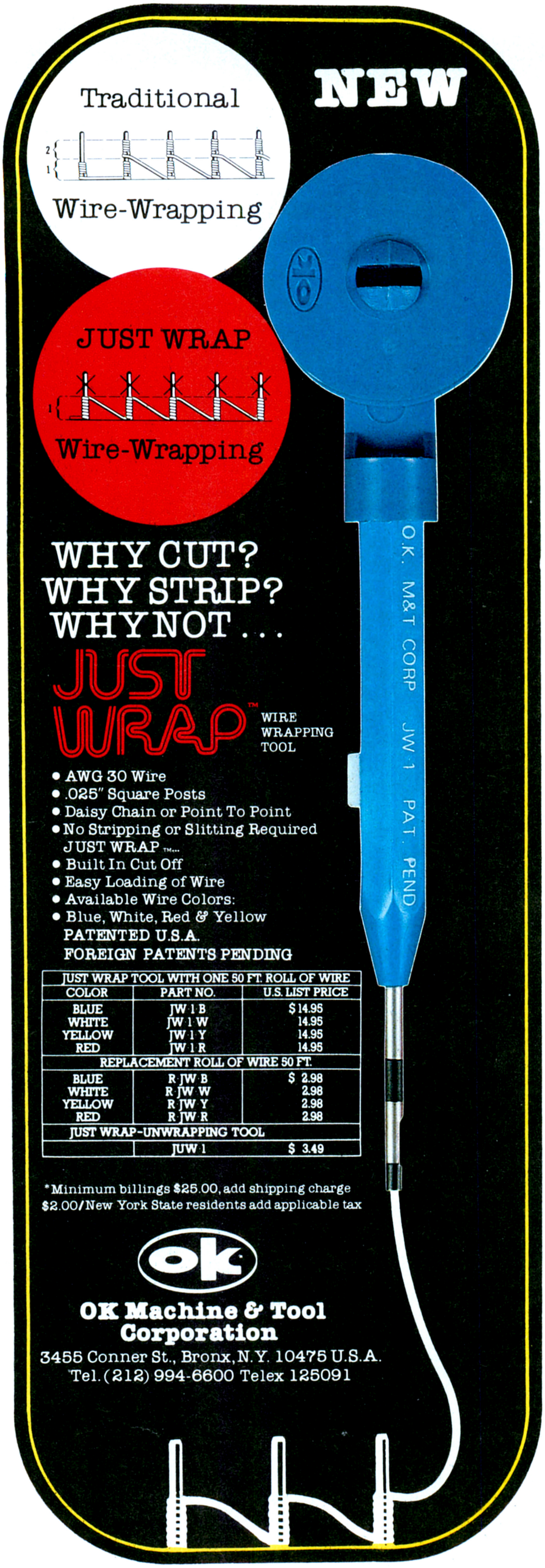

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I	Restore	0	0	0	0	h	V	r_1	r_0
I	Seek	0	0	0	1	h	V	r_1	r_0
I	Step	0	0	1	u	h	V	r_1	r_0
I	Step In	0	1	0	u	h	V	r_1	r_0
I	Step Out	0	1	1	u	h	V	r_1	r_0
II	Read Command	1	0	0	m	b	E	0	0
II	Write Command	1	0	1	m	b	E	a_1	a_0
III	Read Address	1	1	0	0	0	1	0	0
III	Read Track	1	1	1	0	0	1	0	$\overline{s}$
III	Write Track	1	1	1	1	0	1	0	0
IV	Force Interrupt	1	1	0	1	I_3	I_2	I_1	I_0

(a)

BIT VALUES FOR TYPE 1

h = Head Load flag (Bit 3)
h = 1, Load head at beginning
h = 0, Do not load head at beginning
V = Verify flag (Bit 2)
V = 1, Verify on last track
V = 0, No verify
r_1r_0 = Stepping motor rate (Bits 1 thru 0)
r_1r_0 = 11 gives 40 ms step time
u = Update flag (Bit 4)
u = 1, Update Track register
u = 0, No update

(b)

BIT VALUES FOR TYPE II

m = Multiple Record flag (Bit 4)
m = 0, Single record
m = 1, Multiple records
b = Block length flag (Bit 3)
b = 1, IBM format (128 to 1024 bytes)
b = 0, Non-IBM format (16 to 4096 bytes)
a_1a_0 = Data Address Mark (Bits 1 thru 0)
a_1a_0 = 00, FB (Data Mark)
a_1a_0 = 01, FA (User defined)
a_1a_0 = 10, F9 (User defined)
a_1a_0 = 11, F8 (Deleted Data Mark)

(c)

BIT VALUES FOR TYPE III

$\overline{s}$ = Synchronize flag (Bit 0)
$\overline{s}$ = 0, Synchronize to Address Mark
$\overline{s}$ = 1, Do not synchronize to Address Mark

(d)

BIT VALUES FOR TYPE IV

I_0 thru I_3 = Interrupt Condition flags (Bits 3 thru 0)
I_0 = 1, Not Ready to Ready transition
I_1 = 1, Ready to Not Ready transition
I_2 = 1, Index pulse
I_3 = 1, Immediate interrupt
E = Enable HLD and 10 ms Delay
E = 1, Enable HLD, HLT and 10 ms delay
E = 0, Head is assumed engaged and there is no 10 ms delay.

(e)

Table 2: *The high-level instructions of the FD 1771 disk formatter/controller device. When one of the instructions as defined by table 2a is loaded into the command register of the FD1771, the FD1771 executes one or a series of actions. Bits represented by a letter within a command are defined in the bit value tables for that type instruction, tables 2b thru 2e.*

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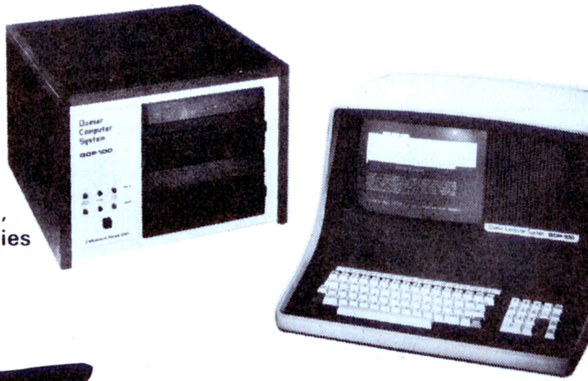

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Text continued from page 80:

Since the Shugart SA400 floppy-disk drive has no "ready" signal, the drive's index signal is used to determine a ready condition.

The disk drive transmits the index pulse only when the drive door is closed, the disk is inserted, and the spindle motor is turning. Because the index pulse is transmitted once for each rotation of the disk, the speed of rotation may be determined by measuring the interval between pulses. When the drive spindle has reached final speed, the index pulse is transmitted at intervals of 200 ms.

I used the index pulse to trigger a monostable multivibrator, which generates a one-shot pulse with a length slightly greater than 200 ms. When the drive is up to speed, the one-shot is continuously activated, since the index pulse retriggers it at 200 ms intervals. This one-shot pulse is connected to the ready line on the FD1771, and the derived "ready" signal remains true as long as the drive is ready.

The HEAD-LOAD and HEAD-LOAD-TIME lines are related in function. When the FD1771 issues a command to the drive, the drive may have to first load the head. The head-load time for a Shugart SA400 drive is 75 ms. Since the FD1771 is designed for use with drives having a shorter head-load time, a time-out signal to indicate that the head is loaded must be generated externally. To insure that the head is loaded, the HEAD-LOAD signal from the FD1771 is tied to a monostable multivibrator having a pulse duration of 75 ms. The output is fed back to the FD1771 as its HEAD-LOAD-TIME input to force the FD1771 to wait for 75 ms before sending a read or write command to the drive.

The FD1771 controls the floppy-disk drive with one of several 8-bit command words; these command words are high-level in the sense that each initiates a series of operations that define the function requested. Generally, each command requires some type of parameter. So, before the 8080A microprocessor sends a command, it must first load the necessary parameter in the form of an 8-bit byte into the appropriate register of the FD1771, whether the destination is the data, sector, or track register.

To place the necessary data in a register, address lines A0 and A1 are set according to the data in table 1, the $\overline{\text{READ-ENABLE}}$ ($\overline{\text{RE}}$) line is held high and the $\overline{\text{WRITE-ENABLE}}$ ($\overline{\text{WE}}$) line is pulled low. To implement a command, lines A0 and A1 must address the command register. An 8-bit byte representing the appropriate command is placed on the data lines of the FD1771 (via the B port of the 8255) and is sent to the command register as the $\overline{\text{WRITE-ENABLE}}$ line is toggled from high to low.

FD1771 Commands

The FD1771 recognizes eleven high-level commands; these are illustrated in table 2 with their binary representations. They can be divided into four types. Type I commands are used to move the drive's read/write head. Type II commands are read- and write-sector commands. Type III commands are read-address, read-track and write-track or formatting

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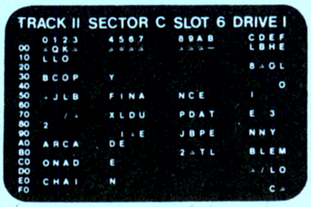

```
TRACK II  SECTOR C  SLOT 6  DRIVE I
    0123   4567   89AB   CDEF
00  ▲QK▲   ▲▲▲▲   ▲▲▲—   LBHE
10  LLO
20                       8▲OL
30  BCOP   Y
40                          O
50  ▲JLB   FINA   NCE    I
60
70    /▲   XLDU   PDAT   E 3
80  2
90          I▲E   JBPE   NNY
A0  ARCA   DE
B0                2▲TL   BLEM
C0  ONAD   E
D0                       ▲/LO
E0  CHAI   N
F0                         C▲
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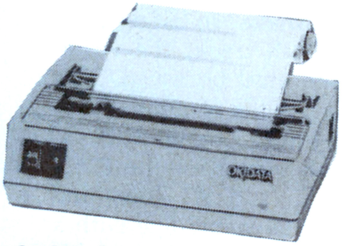

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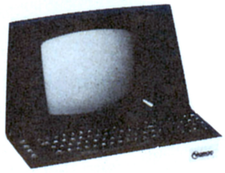

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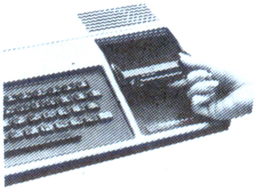

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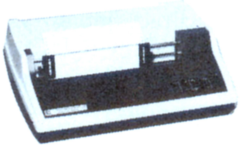

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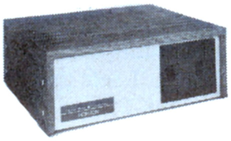

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commands. Type IV includes a class of command that raises the FD1771 interrupt line on a given condition.

The *restore* command causes the addressed drive to move the head to (or *seek*) track 0. When the *seek* command is executed, the addressed disk drive positions the read/write head over the track specified by the 8080A. The *step* command causes the drive to step the head one track in the direction previously selected. The *step-in* command causes the head to step one track toward track 35, the innermost track. With the *step-out* command, the head steps one track toward track 0.

A *read* command transfers a full sector of data, 1 byte at a time, from the disk to the 8080A. A *write* command transfers data for one sector from the microprocessor to the drive. A *read-track* command transfers all bytes of data on a track to the microprocessor. A *read-address* command transfers the next-encountered identification (ID) field to the microprocessor, places the sector address into the sector register, and checks the 2-byte cyclic-redundancy-check (CRC) field. During a *write-track* (format) command, the microprocessor must supply all gap, ID-field, and data bytes except for address marks and CRC bytes.

Data transfers between the 8080A and the floppy-disk drive can be performed using either direct memory access (DMA) or programmed I/O, both of which are supported by the FD1771. I chose programmed I/O, because it is the simpler method of the two, and because it is fast enough for single-density disk drives. With single-density recording, 1 byte is transferred every 64 µs. An average 8080A instruction takes 5 to 6 µs to execute, so that about ten instructions can be executed during the transfer time. This is enough time to gather the data and perform the required housekeeping functions.

Initializing the FD1771

Before the FD1771 can execute commands, it must be initialized. The program shown in listing 1 sets up the control ports of the 8255 PPI so that port A controls certain aspects of disk selection (as well as the $\overline{\text{MASTER-RESET}}$ ($\overline{\text{MR}}$) pin of the FD1771); port B transmits the command, data, and status words for communication between the 8255 and the FD1771; and port C controls data exchanges between the two devices. All commands and parameters come from the computer to the FD1771 through port B of the 8255. All data and status information from the disk to the computer uses the same path.

> Data transfers can be performed with either direct memory access (DMA) or programmed input/output.

The initialization routine of listing 1 also checks the status of the FD1771 and initializes all the registers. The stack pointer is set to memory location hexadecimal 0BEF. For large applications, code for a disk-file library could be established in this routine as well.

Formatting the Disk

Formatting the disk is a matter of loading the track-address register with the point at which formatting is to begin, issuing the seek command which moves the head to that location, loading the data register with the format values, and issuing the write-track command to place that format on the disk.

Assuming that the formatting is to begin at track 0 on the disk, for example, a seek routine (such as the one given in listing 2) is executed. First, the seek routine places the track address (which is 0) on port B of the 8255. Then, holding line A0 high and A1 low (see table 1), the routine causes a write operation to the FD1771 to take place by holding the $\overline{\text{READ-ENABLE}}$ line ($\overline{\text{RE}}$) high and pulling the $\overline{\text{WRITE-ENABLE}}$ line ($\overline{\text{WE}}$) low. (See line 2 of table 1.) Similarly, the command code for a seek operation (hexadecimal 10) is placed on port B of the 8255 and is deposited into the command register of the FD1771 by holding both A0 and A1 low and causing a write operation to take place. When the FD1771 receives the command byte, it executes the seek command, ending with the read/write head in position over the appropriate track (here, track 0).

At the end of the operation, the FD1771 automatically raises the logic state on the interrupt line. At the same time, a byte of status information that indicates whether the command operation was successful is made available to the 8080A. Although the byte of status information does not *have* to be interpreted, the status register *must* be read before another operation can be performed. This is the purpose of the code marked "status handshake" in listing 2.

To format each track, the write-track command must be issued. This is done by placing the command byte for the write-track command (hexadecimal F4) on port B of the 8255, setting lines A0 and A1 low, and strobing the write-enable line with a high-to-low transition. Once this command is received, the FD1771 waits for an index pulse from the disk. The data register must then be filled with the contents of the entire track, 1 byte at a time. At the end of the track the disk drive sends the next index pulse, which causes an interrupt. To write the next track, a seek-to-track-1 operation is performed and another write-track command is issued.

Floppy Disk Format

Although the FD1771 permits non-IBM data-storage formats, I chose to use a modified version of the standard IBM format illustrated in figure 3. This is a 16-sector-per-track, 128-byte-per-sector format. In other words, each of the thirty-five tracks of the floppy disk contains sixteen records (see figure 3).

Each track starts with a gap, called G1, of 16 bytes, each containing the value hexadecimal FF. Next come sixteen records, each of which contains an identification (ID) field, a second gap (G2), a data field of 128 bytes, and an inter-record gap, G3, of 26 bytes. The track is finished with approximately 101 bytes of a final G4A gap field.

A 6-byte synchronization, or sync, section begins the identification field and is included to insure that the data separator is in phase with the data. The single-byte address mark (abbreviated as AM) field contains a unique character that defines the beginning of the ID2 section; here, it has a value of hexadecimal FE. The ID2 section

Text continued on page 100

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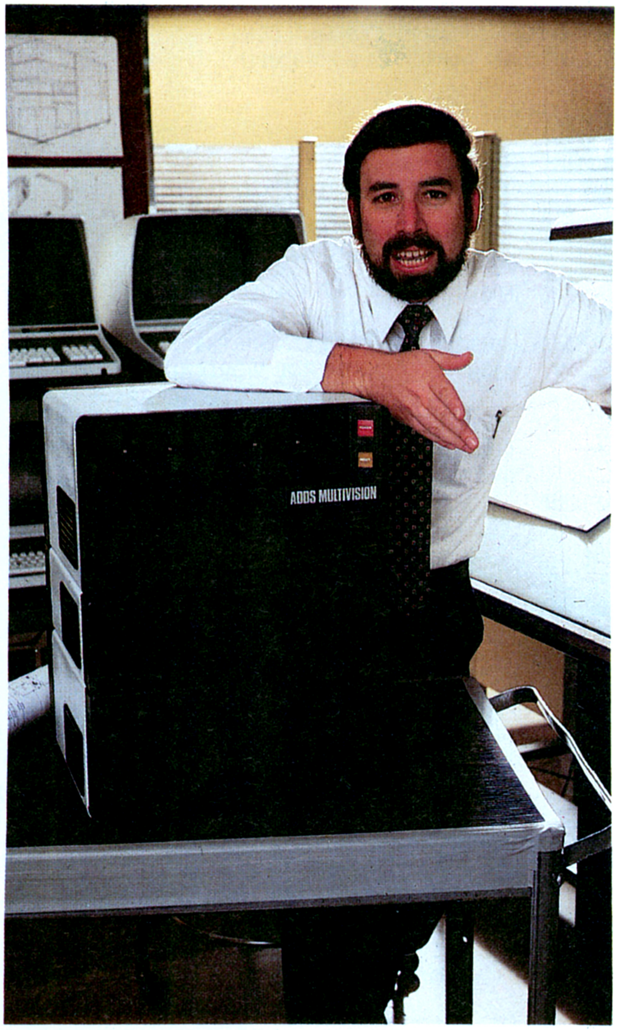
Director of Systems Development



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MULTIVISION

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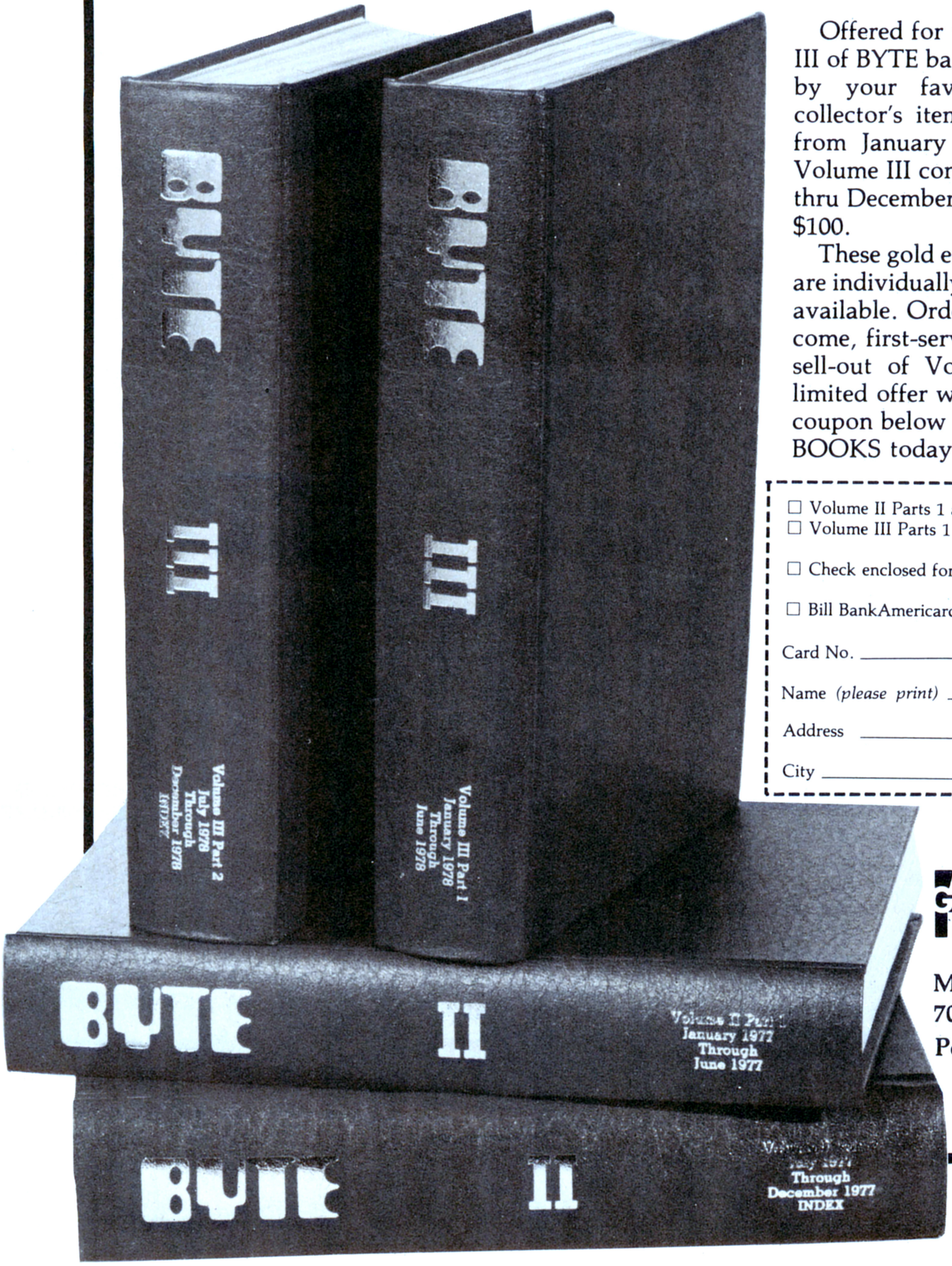
Listing 1: *Program header and initialization routines. This routine initializes the 8255 programmable peripheral interface and sets the read/write head in the floppy-disk drive to track 0.*

```
Hexadecimal      Hexadecimal     Label      Instruction      Commentary
Address          Code                       Mnemonic
                                            and Operand
                                 ; INIT
                                 ;
                                 ;THIS PROGRAM IS DESIGNED TO PERFORM SEEKS,
                                 ;READS, WRITES AND FORMATS USING THE
                                 ;WESTERN DIGITAL FD1771 FLOPPY CONTROLLER
                                 ;CHIP INTERFACED TO AN SA400 AND A 8080 MPU
                                 CTRL       EQU        91H
0091                             ;CONTROL WORD FORMAT:
                                 ;MODE=0
                                 ;PORTA=DATA PORT (INPUTS)
                                 ;PORTB=STATUS AND COMMAND LINES (OUTPUTS)
                                 ;PORTC=INPUTS, 0-3
                                 ;PORTC=OUTPUTS, 4-7
                                 PORTA      EQU        8000H
8000                             PORTB      EQU        8001H         ;PORT A ADDRESS
8001                             PORTC      EQU        8002H         ;PORT B ADDRESS
8002                             CWR        EQU        8003H         ;PORT C ADDRESS
8003                             CHARS      EQU        520H          ;CONTROL WORD ADDRESS
0520                                                                 ;COMMAND CHARACTERS
                                 SEEK       EQU        7D0H           ENTERED VIA CONSOLE
07D0                             READ       EQU        0B10H         ;SEEK TRACK ROUTINE
0B10                             WRITE      EQU        0B80H         ;READ SECTOR ROUTINE
0B80                             PIN        EQU 798H                 ;WRITE SECTOR ROUTINE
0798                                                                 ;PORT B SET AS INPUTS
                                      ORG 600H                        ROUTINE
                 0600            ;
                                 ;INITIALIZE THE PPI (POWER UP)
                                 ;
                                 ;MR ALWAYS=1 AFTER INITIALIZATION
                                 ;
                                 INIT            LXI SP,0BFFH        ;SET THE STACK
0600             31FF0B                          CALL PIN            ;PORTB INPUTS
0603             CD9807                          LXI H,PORTA         ;PORTA ADRS
0606             210080                          MVI A,01H           ;MR=0,DR SEL,MOT ON     PPI
0609             3E01                            MOV M,A             ;WRITE PORTA            INITIALIZE
060B             77                              LXI D,PORTC         ;LOAD PORTC ADRS
060C             110280                          MVI A,O             ;RE,WE=1
060F             3E00                            STAX D              ;WRITE PORTC
0611             12              ;
                                 ;PPI INITIALIZATION DONE
                                 ;RESTORE TO TRACK 0 IS AUTOMATIC
                                 ;
                                 TRK0
0612             3E00                            MVI A,00H           ;MR=1
0614             77                              MOV M,A             ;WRITE PORTA
0615             3E08                            MVI A,08H           ;READ ENAB-STAT REG
0617             12                              STAX D              ;(RE=0) WRITE PORTC
0618             3A0180                          LDA PORTB           ;READ PORTB—GET
                                                                      STATUS
061B             4F                              MOV C,A             ;SAVE STAT REG
061C             3E00                            MVI A,00H           ;RE=1 (MR,WE=1)
061E             12                              STAX D              ;WRITE PORTC
061F             79                              MOV A,C             ;MOV STATUS TO A
0620             E604                            ANI 4H              ;GET TRAK 0 STATUS
0622             FE04                            CPI 4H              ;TRAK 0?
0624             CA1206                          JZ TRKO             ;NO

                                 ;
                                 ;DRIVE NOW AT TRACK 0 — TEST READY
                                 ;
0627             79                              MOV A,C             ;RESTOR STATUS IN A
0628             E680                            ANI 80H             ;GET READY STATUS
062A             FE80                            CPI 80H             ;READY?
062C             CA3506                          JZ INTERP           ;YES GO TO IDLE LOOP
062F             010000                          LXI B,OH            ;ERROR CODE
0632             CD0007                          CALL ERROR
```

Circle 51 on inquiry card. →

LIMITED EDITION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Listing 2: *Seek routine. This routine causes the read/write head to go to (or seek) the track specified by a 2-digit number entered from the system console.*

```
Hexadecimal   Hexadecimal   Label     Instruction     Commentary
Address       Code                    Mnemonic
                                      and Operand

                            ;THIS ROUTINE IS DESIGNED TO SEEK THE
                            ;DRIVE TO A TRACK SPECIFIED BY THE 3RD & 4TH
                            ;CHARACTERS ENTERED BY AN OPERATOR.
              8000          PORTA     EQU 8000H       ;PORT A ADDRESS
              8001          PORTB     EQU 8001H       ;PORT B ADDRESS
              8002          PORTC     EQU 8002H       ;PORT C ADDRESS
              0793          POUT      EQU 793H        ;PORT B SET AS OUTPUTS ROUTINE
              0798          PIN       EQU 798H        ;PORT B SET AS INPUTS ROUTINE
              0769          STATUS    EQU 769H        ;ROUTINE, CONVERTS STATUS TO
                                                       ASCII PRINTABLE DATA
              0520          CHARS     EQU 0520H       ;COMMAND CHARACTERS ENTERED
                                                       VIA CONSOLE.
                            ;
              07D0                    ORG 7D0H        ;
                            ;
                            ;
                            ;FORM THE TRACK ADDRESS FROM THE 3RD & 4TH
                            ;CHARACTERS. 4TH CHARACTER MIGHT BE NEGATIVE
                            ;IF ONLY ONE CHAR WAS ENTERED.
                            ;
07D0          2A2205        SEEK      LHLD CHARS+2    ;GET BOTH CHARS
07D3          7C                      MOV A,H         ;XFR LS CHAR
07D4          B7                      ORA A           ;TERM ?
07D5          F2DC07                  JP TWO          ;NO
07D8          7D                      MOV A,L         ;LOAD SINGLE CHAR
07D9          C3E207                  JMP NEWTRK      ;YES
07DC          7D            TWO       MOV A,L         ;XFR MS CHAR
07DD          07                      RLC             ;SHIFT TO MS POSITION
07DE          07                      RLC
07DF          07                      RLC
07E0          07                      RLC
07E1          84                      ADD H           ;MERGE CHARS

                            ;NOW PUT NEW TRACK ADDRESS IN
                             FDC DATA REGISTER
                            ;
07E2          322008        NEWTRK    STA TRACK       ;SAVE TRACK ADDRESS  )
07E5          CD9307                  CALL POUT       ;PORTB=OUTPUTS       |
07E8          210280                  LXI H,PORTC     ;GET PORT C ADRS     |
07EB          0603                    MVI B,03H       ;A0,A1=1             |
07ED          70                      MOV M,B         ;WRITE PORTC         |
07EE          3A2008                  LDA TRACK       ;TRAK ADRS           |
07F1          2F                      CMA             ;INVERT FOR WD BUS   |
07F2          320180                  STA PORTB       ;WRITE PORTB         |
07F5          0607                    MVI B,07H       ;WRITE TO DATA REG   > COMMAND
07F7          70                      MOV M,B         ;WRITE PORTC         | HANDSHAKE
07F8          0600                    B,00H                                |
07FA          70                      MOV M,B         ;WRITE PORTC         |
                            ;                                              |
                            ;INITIATE SEEK COMMAND                         |
                            ;                                              |
07FB          3E1F                    MVI A,1FH       ;SEEK 40 MS STEP     |
07FD          2F                      CMA                                  |
07FE          320180                  STA PORTB       ;WRITE PORTB         |
0801          0604                    MVI B,04H       ;WRITE TO CMD REG    |
0803          70                      MOV M,B         ;WRITE PORTC         |
0804          0600                    MVI B,00H       ;RE,WE = 1           |
0806          70                      MOV M,B         ;WRITE PORTC         )
                            ;
                            ;WAIT FOR END OF SEEK —
                             THEN REPORT STATUS
                            ;
```

Listing 2 continued on page 92

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Listing 2 continued:

```
0807    CD9807              CALL PIN
080A    7E        WAIT      MOV A,M     ;WAIT FOR END OF SEEK   }
080B    E640                ANI 40H                             }
080D    CA0A08              JZ WAIT                             }
0810    3E08                MVI A,08H   ;STAT REG READ          } STATUS
0812    77                  MOV M,A     ;WRITE PORTC            } HANDSHAKE
0813    3A0180              LDA PORTB   ;BRING STATUS           }
0816    0600                MVI B,00H   ;RE,WE=1                }
0818    70                  MOV M,B     ;WRITE PORT B           }
0819    2F                  CMA         ;INVERT
081A    E618                ANI 18H     ;SEEK AND CRC BITS
                  ;
081C    CD6907              CALL        ;REPORT TO CONSOLE
                            STATUS
081F    C9                  RET
                  ;
0820    00        TRACK     BYTE 0
        07D0                END SEEK
```

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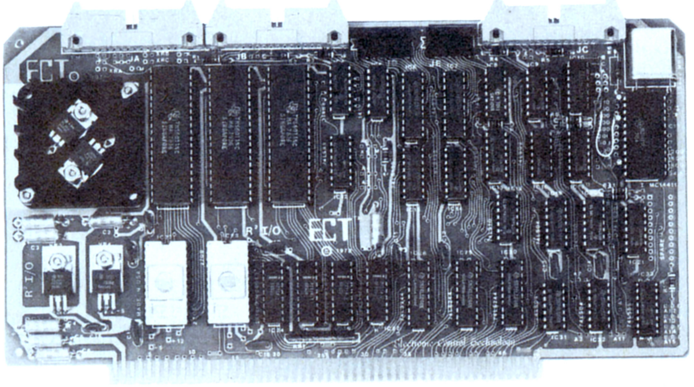

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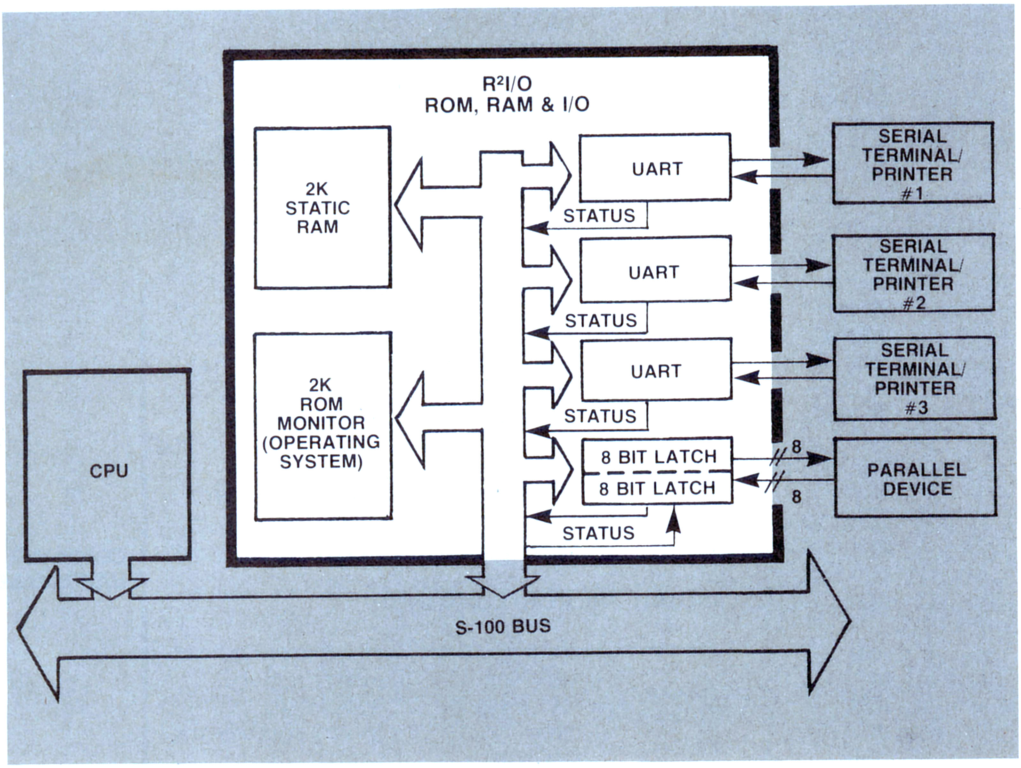
- ROM Monitor (Operating System)
- 3 Serial I/O Ports
- 1 Parallel I/O Port
- 4 Status Ports

ELECTRONIC CONTROL TECHNOLOGY's R²I/O is an S-100 Bus I/O Board with 3 Serial I/O Ports (UART's), 1 Parallel I/O Port, 4 Status Ports, 2K of ROM with Monitor Program and 2K of Static RAM. The R²I/O provides a convenient means of interfacing several I/O devices, such as – CRT terminals, line printers, modems or other devices, to an S-100 Bus Microcomputer or dedicated controller. It also provides for convenient Microcomputer system control from a terminal keyboard with the 8080 Apple ROM monitor containing 26 Executive Commands and I/O routines. It can be used in dedicated control applications to produce a system with as few as two boards, since the R²I/O contains ROM, RAM and I/O.

The standard configuration has the Monitor ROM located at F000 Hex with the RAM at F800 Hex and the I/O occupies the first block of 8 ports. Jumper areas provide flexibility to change these locations, within reason, as well as allow the use of ROM's other than the 2708 (e.g. 2716 or similar 24 pin devices). Baud rates are individually selectable from 75 to 9600. Voltage levels of the Serial I/O Ports are RS-232.



8080 APPLE MONITOR COMMANDS

A – Assign I/O
B – Branch to user routine A-Z
C – Undefined
D – Display memory on console in Hex
E – End of file tag for Hex dumps
F – Fill memory with a constant
G – GOTO an address with breakpoints
H – Hex math sum & difference
I – User defined
J – Non-destructive memory test
K – User defined
L – Load a binary format file
M – Move memory block to another address
N – Nulls leader/trailer
O – User defined
P – Put ASCII into memory
Q – Query I/O ports: QI (N)-read I/O; QO(N,V)-send I/O
R – Read a Hex file with checksum
S – Substitute/examine memory in Hex
T – Types the contents of memory in ASCII equivalent
U – Unload memory in Binary format
V – Verify memory block against another memory block
W – Write a checksummed Hex file
X – Examine/modify CPU registers
Y – 'Yes there' search for 'N' Bytes in memory
Z – 'Z END' address of last R/W memory location

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Listing 3: *Read-sector routine. This routine causes the contents of a given sector of the current track (specified by a 2-digit number entered from the system console) to be transferred from the disk drive to an area of memory starting at the location given by the value of DATBUF, using decreasing memory addresses.*

```
Hexadecimal   Hexadecimal   Label     Instruction     Commentary
Address       Code                    Mnemonic
                                      and Operand

                            ;READ READ SECTOR ROUTINE
                            ;
                            ;READ SECTOR ROUTINE INITIATES THE READ
                            ;COMMAND AND TRANSFERS ALL THE DATA FOR A
                            ;SELECTED SECTOR TO THE BOTTOM OF MEMORY
                            ;BEGINNING AT LOCATION 5FF
                            ;R,XX READ SECTOR, SECTOR ADRS
              8000          PORTA     EQU 8000H       ;PORT A ADDRESS
              8001          PORTB     EQU 8001H       ;PORT B ADDRESS
              8002          PORTC     EQU 8002H       ;PORT C ADDRESS
              0793          POUT      EQU 793H        ;PORT B SET AS OUTPUTS ROUTINE
              0798          PIN       EQU 798H        ;PORT B SET AS INPUTS ROUTINE
              0769          STATUS    EQU 769H        ;ROUTINE CONVERTS STATUS TO
                                                       ASCII PRINTABLE DATA
              05FF          DATBUF    EQU 5FFH        ;BEGINNING ADRS OF "READ"
                                                       DATA BUFFER
              0520          CHARS     EQU 520H        ;COMMAND CHARACTERS ENTERED
                                                       VIA CONSOLE
                            ;
              0B10                    ORG 0B10H
                            ;
0B10          2A2205        READ      LHLD CHARS+2    ;GET BOTH CHARS
0B13          7C                      MOV A,H         ;XFER LS CHAR
0B14          B7                      ORA A           ;TERM?
0B15          F21C0B                  JP TWO          ;NO
0B18          7D                      MOV A,L         ;LOAD SINGLE CHAR
0B19          C3220B                  JMP SECTOR
0B1C          7D            TWO       MOV A,L         ;XFER MS CHAR
0B1D          07                      RLC             ;SHIFT TO MS POSITION
0B1E          07                      RLC
0B1F          07                      RLC
0B20          07                      RLC
0B21          84                      ADD H           ;MERGE CHARS
0B22          327C0B        SECTOR    STA SECSTR      ;STOR SECTOR              ┐
0B25          CD9307                  CALL POUT       ;PORTB OUTPUTS            │
0B28          210280                  LXI H,PORTC     ;GET PORTC ADRS           │
0B2B          0602                    MVI B,02H       ;SECTOR REGISTER          │
0B2D          70                      MOV M,B         ;WRITE PORTC              │
0B2E          3A7C0B                  LDA SECSTR      ;SECTOR ADRS              │
0B31          2F                      CMA             ;INVERT FOR WD BUS        │
0B32          320180                  STA PORT B      ;WRITE PORTB              │
0B35          0606                    MVI B,06H       ;WRITE TO SECTOR          │
                                                       REG                      │
0B37          70                      MOV M,B         ;WRITE PORTC              ├ COMMAND
                            ;                                                   │ HANDSHAKE
                            ;INITIATE THE READ COMMAND                          │
                            ;                                                   │
0B38          0600                    MV B,0          ;SEL CMD REG              │
0B3A          70                      MOV M,B         ;WRITE PORTC              │
0B3B          3E88                    MVI A,88H       ;READ CMD                 │
0B3D          2F                      CMA             ;INVRT FOR WD BUS         │
0B3E          320180                  STA PORTB       ;WRITE PORTB              │
0B41          0604                    MVI B,04H       ;ISSUE READ TO            │
                                                       CMD REG                  │
0B43          70                      MOV M,B         ;WRITE PORTC              ┘

                            ;
                            ;WAIT FOR END OF READ — THEN REPORT
                            ;
```

Listing 3 continued on page 96

POWER-ONE D.C. POWER SUPPLIES

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Power-One, the leader in quality open-frame power supplies, now offers a complete line of single, dual, and triple output models for small computer systems. Also available are special purpose models for Floppy Disk and Microcomputer applications.

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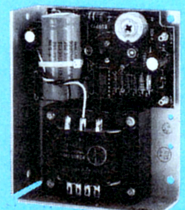
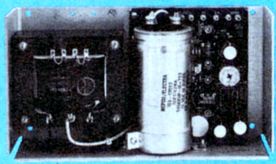
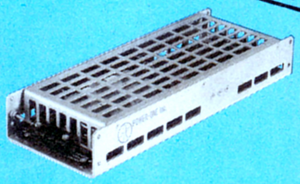
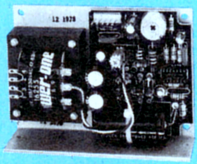
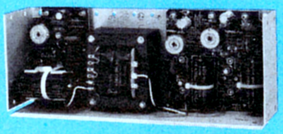
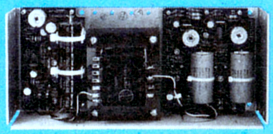
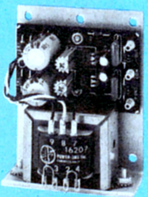
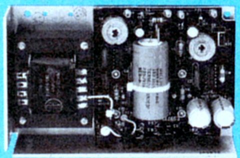
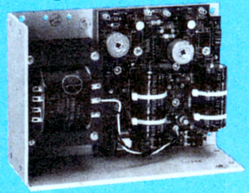
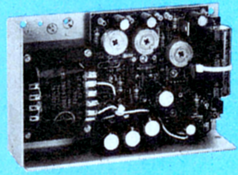
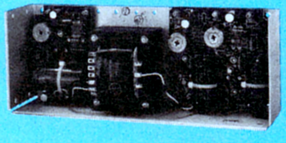
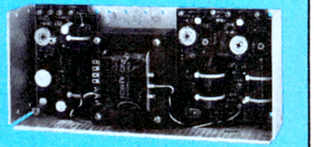
SINGLE OUTPUT & LOGIC POWER SUPPLIES - 56 ''off the shelf'' models - 2V to 250V, 0.1A to 40A - ± .05% regulation - 115/230 VAC input	**5V @ 3A, w/OVP**  HB5-3/OVP $24.95 single qty.	**5V @ 12A, w/OVP**  HD5-12/OVP $79.95 single qty.	**5V @ 40A, w/OVP** **NEW**  SK5-40/OVP Switching Model $250.00 single qty.
FLOPPY-DISK SERIES - 8 ''off the shelf'' models - Powers most popular drives - Single/dual drive applications - 2-year warranty	**5V @ 0.7A, w/OVP** **12V @ 1.1A/1.7A PK** **NEW**  CP340 For one 5.25'' Media Drive $44.95 single qty.	**5V @ 1A, w/OVP** **– 5V @ 0.5A, w/OVP** **24V @ 1.5A/1.7A PK**  CP205 For one 8.0'' Media Drive $69.95 single qty.	**5V @ 2.5A, w/OVP** **– 5V @ 0.5A, w/OVP** **24V @ 3A/3.4A PK**  CP206 For two 8.0'' Media Drives $91.95 single qty.
DUAL OUTPUT MODELS - 15 ''off the shelf'' models - ± 5V to ± 24V, 0.25A to 6A - I.C. regulated - Full rated to + 50° C	**12V/15V @ 0.25A** **NEW**  HAD12-.25/HAD15-.25 $32.95 single qty.	**5V @ 2A, w/OVP** **9 – 15V @ 0.5A**  HAA512 $44.95 single qty.	**± 12V @ 1.7A or** **± 15V @ 1.5A**  HBB15-1.5 $49.95 single qty.
TRIPLE OUTPUT MODELS - 10 ''off the shelf'' models - 5V plus ± 9V to ± 15V outputs - Models from 16W to 150W - Industry standard size	**5V @ 2A, w/OVP** **± 9V to ± 15V @ 0.4A**  HTAA-16W $49.95 single qty.	**5V @ 3A, w/OVP** **± 12V @ 1A or** **± 15V @ 0.8A**  HBAA-40W $69.95 single qty.	**5V @ 6A, w/OVP** **± 12V @ 1.7A or** **± 15V @ 1.5A**  HCBB-75W $91.95 single qty.

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Circle 55 on inquiry card.

Listing 3 continued:

```
0B44    0603              MVI B,03H     ;SEL DATA REG
0B46    70                MOV M,B       ;WRITE PORTC
0B47    CD9807            CALL PIN      ;PORTB = INPUTS
0B4A    11FF05            LXI D,DATBUF  ;FWA OF DATA
0B4D    0603              MVI B,03H     ;RE,WE=1
0B4F    C35C0B            JMP DLOOP
0B52    3E0B      GD      MVI A,0BH     ;RE=0              DATA
0B54    77                MOV M,A       ;WRITE PORTC       TRANSFER
0B55    3A0180            LDA PORTB     ;GET DATA          SEQUENCE
0B58    2F                CMA           ;INVERT DATA
0B59    12                STAX D        ;SAVE IT
0B5A    1B                DCX D         ;BUMP INDEX
0B5B    70                MOV M,B       ;RE=1,PORTC
0B5C    7E        DLOOP   MOV A,M       ;GET STATUS
                                         PORTC
0B5D    B7                ORA A         ;DRQ=1?
0B5E    FA520B            JM GD         ;YES
0B61    E640              ANI 40H       ;INTRQ SET?
0B63    CA5C0B            JX DLOOP      ;NO
                  ;
                  ;READ DONE — GET STATUS
                  ;
0B66    3E00              MVI A,O       ;ADRS STAT REG
0B68    77                MOV M,A       ;WRITE PORTC
0B69    3E08              MVI A,08H     ;STROBE RE=0
0B6B    77                MOV M,A       ;WRITE PORTC
0B6C    EB                XCHG                             STATUS
0B6D    227E0B            SHLD ISAVE    ;SAVE INDEX TO     HANDSHAKE
                                         DATA
0B70    EB                XCHG          ;RESTOR PORTC
                                         ADRS
0B71    3A0180            LDA PORTB     ;GET STAT BYTE
0B74    0600              MVI B,0       ;STAT HANDSHAKE
0B76    70                MOV M,B       ;WRITE PORTC
0B77    2F                CMA           ;INVERT STAT
                                         BYTE
0B78    CD6907            CALL STATUS   ;REPORT STATUS
0B7B    C9                RET
                  ;
0B7C    0000      SECSTR  WORD 0        ;SECTOR ADRS
0B7E    0000      ISAVE   WORD 0        ;DATA INDEX
                                         STORAGE AREA
        0B10              END READ
```

Listing 4: *Write-sector routine. This routine causes a section of memory to be written to a given sector on the disk. The sector number is specified by a 2-digit number entered from the system console.*

```
Hexadecimal   Hexadecimal   Label   Instruction    Commentary
Address       Code                  Mnemonic
                                    and Operand

                            ;WRITE WRITE SECTOR ROUTINE
                            ;
                            ;WRITE SECTOR ROUTINE INITIATES THE WRITE
                            ;COMMAND AND TRANSFERS ALL THE DATA FOR A
                            ;SELECTED SECTOR
                            ;
                            ;W,XX = WRITE SECTOR,SECTOR ADRS
8000          PORTA                 EQU 8000H      ;PORT A ADRS
8001          PORTB                 EQU 8001H      ;PORT B ADRS
8002          PORTC                 EQU 8002H      ;PORT C ADRS
0793          POUT                  EQU 793H       ;PORT B SET AS
                                                    OUTPUTS
                                                    ROUTINE
0798          PIN                   EQU 798H       ;PORT B SET AS
                                                    INPUTS ROUTINE
0769          STATUS                EQU 769H       ;ROUTINE
                                                    CONVERTS
                                                    STATUS TO ASCII
                                                    PRINTABLE DATA
0520          CHARS                 EQU 520H       ;COMMAND CHAR-
```

Listing 4 continued on page 98

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Columbus, Ohio 43220

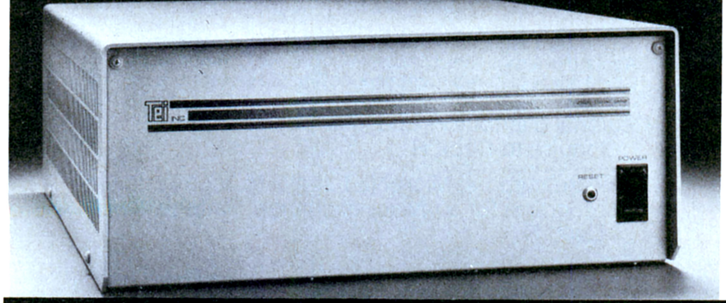
Listing 4 continued:

```
                                                   ACTERS ENTERED
                                                   VIA CONSOLE
                                 ;
               0B80                    ORG 0B80H
                                 ;
0B80           2A2205            READ  LHLD CHARS  ;GET BOTH CHARS
                                       +2
0B83           7C                      MOV A,H     ;XFER LS CHAR
0B84           B7                      ORA A       ;TERM?
0B85           F28C0B                  JP TWO      ;NO
0B88           7D                      MOV A,L     ;LOAD SINGLE
                                                    CHAR
0B89           C3920B                  JMP SECTOR
0B8C           7D                TWO   MOV A,L     ;XFER MS CHAR
0B8D           07                      RLC         ;SHIFT TO MS
                                                    POSITION
0B8E           07                      RLC
0B8F           07                      RLC
0B90           07                      RLC
0B91           84                      ADD H       ;MERGE CHARS
0B92           32E50B            SECTOR STA SECSTR ;STOR SECTOR
0B95           CD9307                  CALL POUT   ;PORTB OUTPUTS
0B98           210280                  LXI H,PORTC ;GET PORTC ADRS
0B9B           0602                    MVI B,02H   ;SECTOR
                                                    REGISTER
0B9D           70                      MOV M,B     ;WRITE PORTC
0B9E           3AE50B                  LDA SECSTR  ;SECTOR ADRS
0BA1           2F                      CMA         ;INVERT FOR WD
                                                    BUS
0BA2           320180                  STA PORTB   ;WRITE PORTB       COMMAND
0BA5           0606                    MVI B,06H   :WRITE TO          HANDSHAKE
                                                    SECTOR REG
0BA7           70                      MOV M,B     ;WRITE PORTC
                                 ;
                                 ;INITIATE THE READ COMMAND
                                 ;
0BA8           0600                    MVI B,O     ;SEL CMD REG
0BAA           70                      MOV M,B     ;WRITE PORTC
0BAB           3EA8                    MVI A,0A8H  ;WRITE CMD
0BAD           2F                      CMA         ;INVRT FOR WD
                                                    BUS
0BAE           320180                  STA PORTB   ;WRITE PORTB
0BB1           0604                    MVI B,04H   ;ISSUE READ TO
                                                    CMD REG
0BB3           70                      MOV M,B     ;WRITE PORTC
```

Listing 4 continued on page 100

The Mainframe.

(or how to get a good night's sleep)



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Circle 57 on inquiry card.

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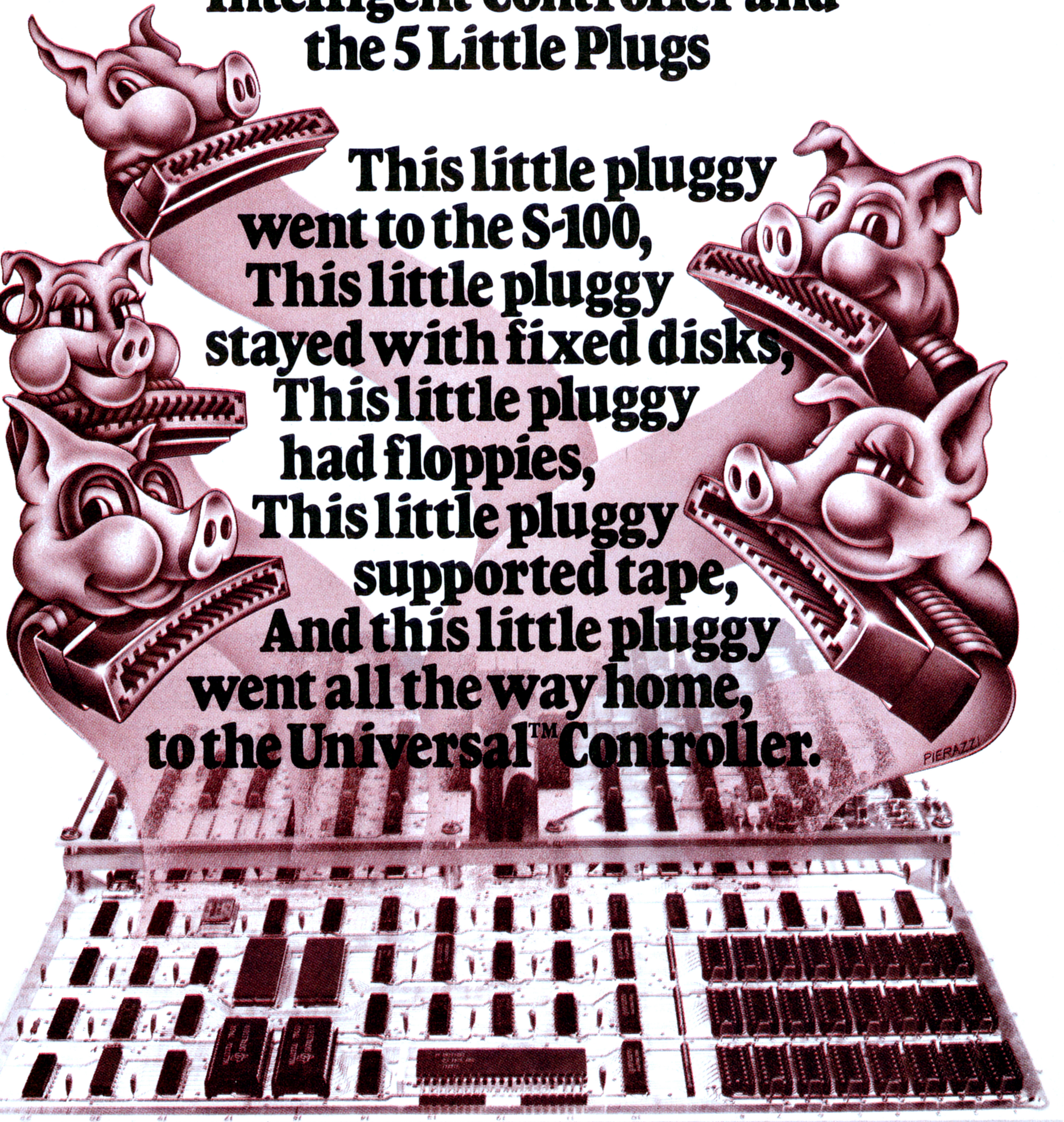

This little pluggy
went to the S-100,
This little pluggy
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This little pluggy
supported tape,
And this little pluggy
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DATA MANAGEMENT LABS

Circle 58 on inquiry card.

Listing 4 continued:

```
                                WAIT FOR END OF READ — THEN REPORT

0BB4        0603                    MVI B,03H      ;SEL DATA REG       \
0BB6        70                      MOV M,B        ;WRITE PORTC         |
0BB7        110180                  LXI D,PORTB    ;PORTB ADRS          |
0BBA        0603                    MVI B,03H      ;RE,WE=1             |
0BBC        C3C70B                  JMP DLOOP                           |
0BBF        3E8D          GD        MVI A,8DH      ;LOAD DATA           |
0BC1        2F                      CMA            ;INVRT DATA          |  DATA
0BC2        12                      STAX D         ;WRITE PORT B        >  TRANSFER
0BC3        3E07                    MVI A,07H      ;WE=0                |  HANDSHAKE
0BC5        77                      MOV M,A        ;WRITE PORTC ·       |
0BC6        70                      MOV M,B        ;RE=1,PORTC          |
0BC7        7E            DLOOP     MOV A,M        ;GET STATUS          |
                                                    PORTC               |
0BC8        B7                      ORA A          ;DRQ=1               |
0BC9        FABF0B                  JM GD          ;YES                 |
0BCC        E640                    ANI 40H        ;INTERQ SET          |
0BCE        CAC70B                  JZ DLOOP       ;NO                 /
                                READ DONE — GET STATUS

0BD1        CD9807                  CALL PIN       ;PORTB INPUTS       \
0BD4        3E00                    MVI A,0        ;ADRS STAT REG       |
0BD6        77                      MOV M,A        ;WRITE PORTC         |
0BD7        3E08                    MVI A,08H      ;STROBE RE=0         >  STATUS
0BD9        77                      MOV M,A        ;WRITE PORTC         |  HANDSHAKE
0BDA        3A0180                  LDA PORTB      ;GET STAT BYTE       |
0BDD        0600                    MVI B,0        ;STAT HANDSHAKE      |
0BDF        70                      MOV M,B        ;WRITE PORTC        /
0BEO        2F                      CMA            ;INVERT STAT
                                                    BYTE
0BE1        CD6907                  CALL STATUS    ;REPORT STATUS
0BE4        C9                      RET

0BE5        0000          SECSTR    WORD 0         ;SECTOR ADRS
            0B80                    END READ
```

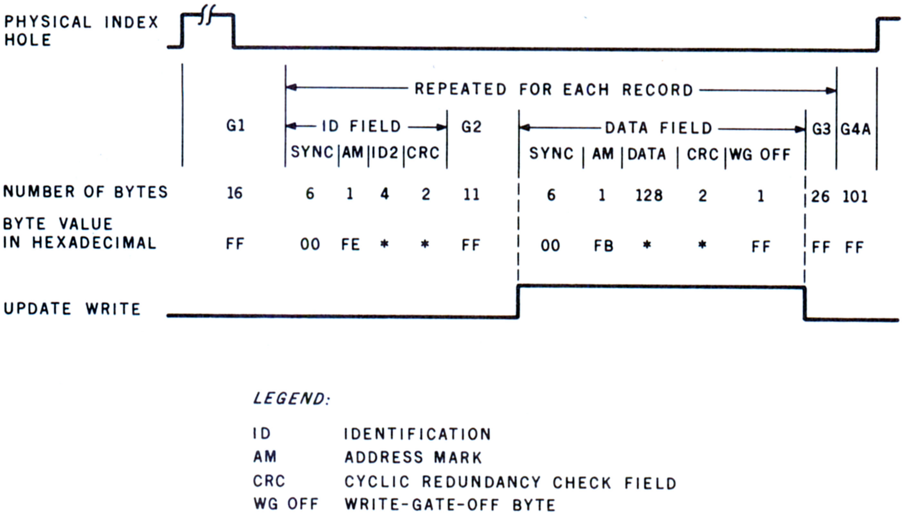
PHYSICAL INDEX HOLE
REPEATED FOR EACH RECORD
G1
ID FIELD
G2
DATA FIELD
G3
G4A
SYNC
AM
ID2
CRC
SYNC
AM
DATA
CRC
WG OFF
NUMBER OF BYTES
16
6
1
4
2
11
6
1
128
2
1
26
101
BYTE VALUE IN HEXADECIMAL
FF
00
FE
*
*
FF
00
FB
*
*
FF
FF
FF
UPDATE WRITE
LEGEND:
ID IDENTIFICATION
AM ADDRESS MARK
CRC CYCLIC REDUNDANCY CHECK FIELD
WG OFF WRITE-GATE-OFF BYTE

Figure 3: *Format of data as recorded on one track of the disk drive. Each track contains sixteen records, each of which contains 128 bytes. Each record consists of an identification (ID) field followed by a data field. The columns marked with an asterisk represent fields with contents that vary from record to record.*

Text continued from page 86:

contains the following: track address, side-select byte (set to 00 here), sector address, and sector length (set to 00 here because the sector length is constant); each field is 1 byte long. The cyclic-redundancy-check (CRC) section contains a 2-byte value that serves to check the accuracy of the previous bytes as written onto the disk. A command byte of hexadecimal F7 sent to the FD1771 controller causes it to generate and write the CRC bytes.

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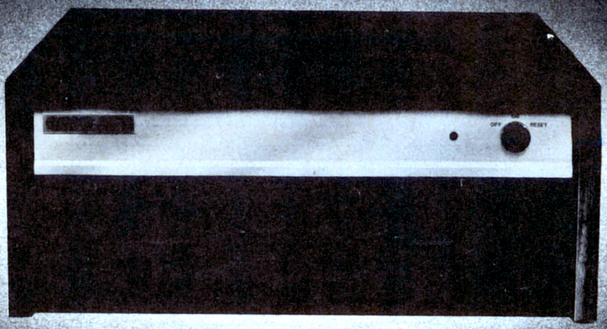

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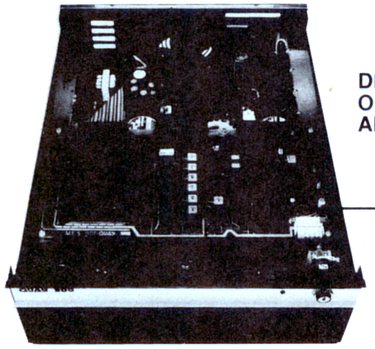

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turned off from the write mode without destroying any valid data. Although a hexadecimal FF is written to this field, we do not care what value resides in the WG-off field on the floppy disk.

Once the disk is formatted, reading or writing can begin. The read and write commands are similar in several respects to other commands such as the seek command. Each must be part of a software routine in which a command parameter is loaded into the data, sector, or track register, and the command itself is loaded into the command register. All commands also generate an interrupt signal at their completion. This interrupt must be reset through a status handshake routine that reads the status register.

However, the read and write commands differ from commands like the seek command in the following one respect: data must be transferred. For example, a write command, in a data-transfer routine like that presented in hexadecimal locations 0BB4 thru 0BCE of listing 4, places a byte of data in port B and points the address pointers (lines A0 and A1) to the data register. When the FD1771 raises the DRQ line, the $\overline{\text{WRITE-ENABLE}}$ line is brought low. The byte of data, which is placed in the FD1771 data register, is transferred from the FD1771 to the disk. The 8080A places another byte in the port and pulls the $\overline{\text{WRITE-ENABLE}}$ line low again when the FD1771 signals that it is ready to accept another byte of data. A similar procedure is followed for a read command (see listing 3), except that this command uses the $\overline{\text{READ-ENABLE}}$ line.

This concludes our discussion of the hardware and software necessary to interface a Shugart SA400 disk drive to an 8080A-based microcomputer system. Additional application information is given in the application notes available from the companies listed in the references. ■

References

1. *SA400/450 Minifloppy Diskette Storage Drives with an 8080A/FD1771 Single Density System Application Bulletin,* Shugart Associates, 415 Oakmead Parkway, Sunnyvale CA 94086
2. *FD1771 Floppy Disk Formatter/Controller Data Sheet,* Western Digital Corporation, 3128 Red Hill Ave, POB 2180, Newport Beach CA 92663
3. *Intel 8080 Microcomputer Systems User's Manual,* Intel Corporation, 3065 Bowers Ave, Santa Clara CA 95051

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The Commands

With what commands should the editor provide the user in order to make the program easy to use, and how does the nature of these commands affect the structure of the program?

Mode Commands

We begin to answer this question by distinguishing three major ways in which the user will use the program. The first is when the user creates a score of music. Here the editor must establish a file for the score and allow the user to overwrite the default values for the music, such as the key and time signatures. The second major use consists of editing the score. The program needs to provide facilities for locating the measure to be edited, reformatting the pages after editing, and writing the finished version out to a file. The third and hardest facility the editor must provide is the ability to display the score on the screen.

A multitude of problems must be handled automatically by the editor in adjusting the format of the score as it will appear on the screen. The above discussion leads to a definition of three separate modes of operation for the editor called the CREATE, EDIT, and DISPLAY modes. Switching between modes is done by issuing a command through the graphics tablet as discussed in part 1. The editor also switches modes automatically to display the contents of a measure while the user creates or edits the score.

Location Commands

Commands must be provided to allow sequential passage through the score. In order to do this, the user must first set a symbolic-operation mode which determines the units to be used as increments in moving through the score. These units are pages, lines, measures, or characters, and are set via commands on the template. For example, suppose you are located on page two, line one, measure three, and character twenty-one of the score, and you wish to edit page five, line four, measure one, and character three. The following sequence of commands will accomplish this:

1. Touch page. This sets the increments to pages, and sets the line, measure, and character values to one.
2. Touch forward three times. This positions you on the first line, measure, and character of page five.
3. Touch line. Touch forward three times. You are now at the first measure of line four.
4. Touch character and touch forward two times.

If you are editing the end of a unit, it is often faster to back up. If you were editing the last character, number thirty-seven, of measure one above, you could go to measure two and then back up one character rather than going forward from measure one, thirty-seven times. If the program is to provide this flexible location scheme to the user, it should be easy to determine the location of the page, line, measure, and character at any place in the score. A look back at the data structures indicates that this was accomplished using doubly-linked pointers between the score area arrays.

Edit Commands

The program must support all editing features that allow easy text manipulation. Commands to insert, delete, replace, or move pages, measures, lines, or characters must be provided, as well as methods of searching the text for patterns of music. These facilities require a set of routines that will automatically adjust the paging of the music after editing.

Note
The figure numbering sequence is continued from part 1 which appeared in the April 1980 BYTE.

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Exit Commands

After editing a measure, the user either wants the version to become a permanent part of the score, or wishes to inform the program to ignore any changes made. This is the function of the EXIT and NULL-EXIT commands on the template. Note that the exit command must transfer the contents of the work area to the score area and make the necessary format changes while the NULL-EXIT simply does nothing.

Symbols

Music abounds with symbols. The template shown in part 1 indicates only a few. The actual design allows for one hundred different symbols. In order to avoid cluttering the template you would have to cull the necessary symbols for the type of music that is being scored. To transfer from one notational style to another is not a difficult task, since only the template and interface program would have to be changed. The main portion of the editor is protected from such alterations.

Output

The hardest problems of the editor are related to displaying the musical score on the screen in a pleasing and useful format. I will touch on three classes of problems, and outline their solutions in this section.

Dimension Problems

This set of problems is caused by the physical dimensions of the screen output. The actual physical dimensions of the height and length of the screen are fixed, and you must work around their limitations. Since most graphics screens represent points in a coordinate system, the maximum and minimum absolute coordinates for the X and Y axis are set.

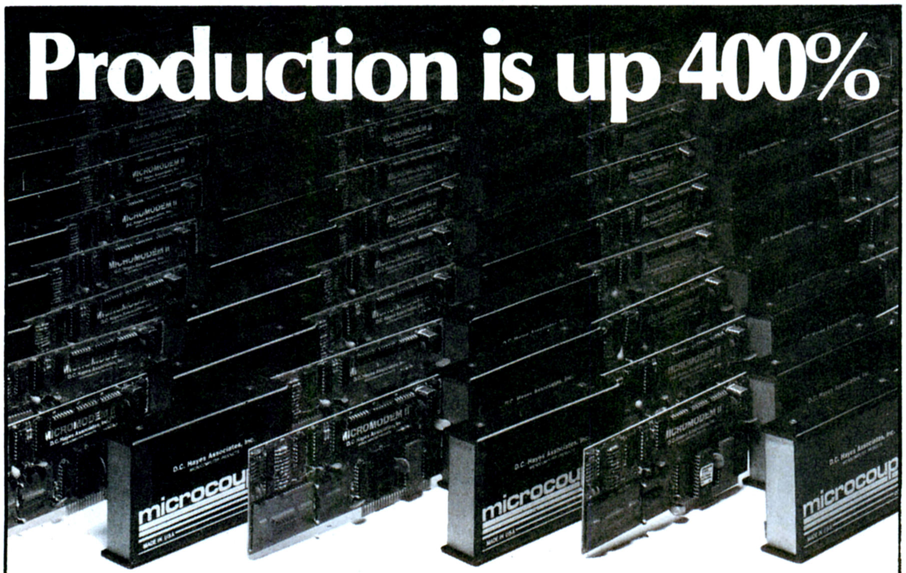
In order to achieve a flexible design, no commitment should be made to any of these machine-dependent characteristics. Instead, you should work in a virtual coordinate space controlled by the editor, and write another interface program to handle the conversion of coordinates in the virtual space to the actual screen coordinates. Every dimension that is given will then represent a dimension of the virtual space in the editor. Since the option of determining the size of a score of music should be left to the user, you must understand that all dimensions are subject to scaling factors that will be set by the user on entrance to the program. With these considerations in mind, I will now discuss three problems and their solutions.

1. The Spacing Problem for the Staff

How are the dimensions for the staff, notes, and symbols determined? The solution was found by taking measurements from scores of music and determining the standard sizes. Figure 5 shows the dimensions of the staff and lists the dimensions for other symbols. Note that all dimensions are given in terms of LSPACE, which is the distance between the lines of the staff.

2. The Length of the Measure Problem

How do you assign a virtual length to a measure? Although each measure has the same number of beats, their lengths can differ radically. Observe in figure 7 that the length between notes of the same value is not always equal. This eliminates a simple method in which you would assign virtual lengths to specific note values



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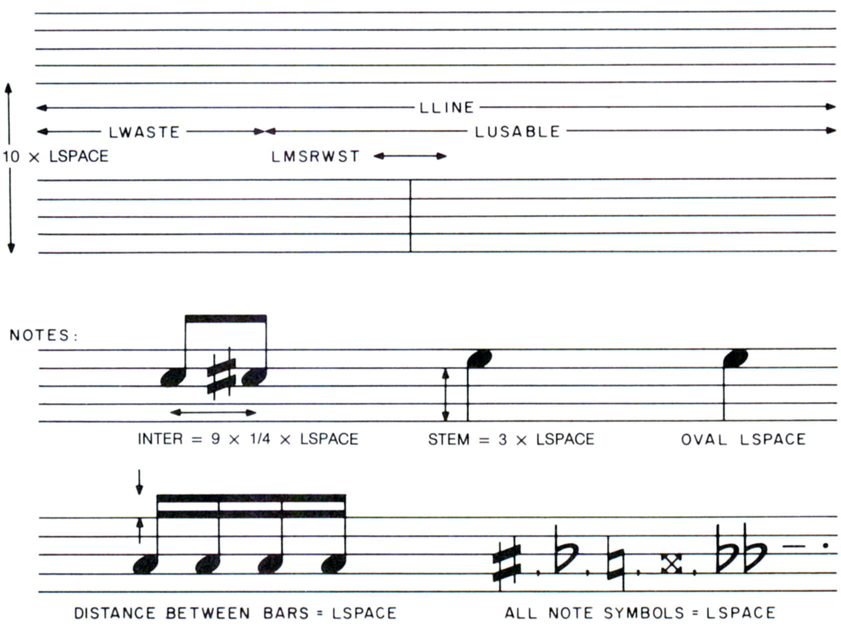

Figure 5: *Dimensions of the musical staff, notes, and symbols. All dimensions are given in terms of LSPACE, the distance between the lines of the staff.*

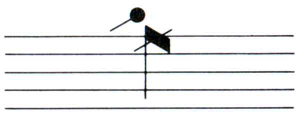

Figure 6: *An example of a rarely occurring musical symbol. Of the many thousands of symbols which are used to communicate different forms of expression, some are used only infrequently. This particular symbol is found in piano music. It directs the performer to reach inside the instrument and strike the string corresponding to the indicated note with a mallet.*

and determine the total length of the measure by summing their values. A modified approach to this simple scheme can be adopted, however. You must first determine the minimum distance between notes that allows sharps and flats to be inserted, while still preserving readability. This distance can be fine-tuned to the eye of the user, but it is approximately nine-fourths the distance between the lines of the staff, or $(9/4) \times$LSPACE. This dimension will be called the *internote distance,* denoted by INTER. Second, a *beaming group* is defined as a set of notes that are connected by beams. Later I will discuss a routine that determines beaming groups in the measure. Assume here that the job has been done. Next, a code for each possible note value is determined (this code was actually developed much earlier and is used throughout the program in most of the data structures). This information is shown in table 5. Notice that all the values are integer quotients of 20160. There are several reasons for this particular encoding scheme. First, the editor allows for twenty-six different note values. In order that the subgroupings of these notes add up to correct total values, each note must have the same common denominator. The value 20160 fulfills the requirement. The code for one beat is 5040. Other reasons for this encoding concern the eventual placement of the notes in their proper screen locations. The total length of the measure is now the sum of the lengths of all of the beaming groups of that measure plus the lengths of the rests. The algorithm for determining the length for the beaming groups can now be stated:

1. Determine the total number of beats for the beaming group. This can be done by summing the codes for all the notes in the group and dividing by 5040, the value for one beat. Let this value be NUM.
2. Find the minimum value for the beaming group. Call this MIN.
3. Determine the number of notes required if the total number of beats were to be taken up by the minimum note. This is simply NUM / MIN.
4. Multiply this number by the internote distance. Thus you finally get the length, which is equal to (NUM / MIN × INTER.

You can now perform the above routine for all of the beaming groups of the measure and sum up the lengths, with rests included. The total value represents the virtual length of

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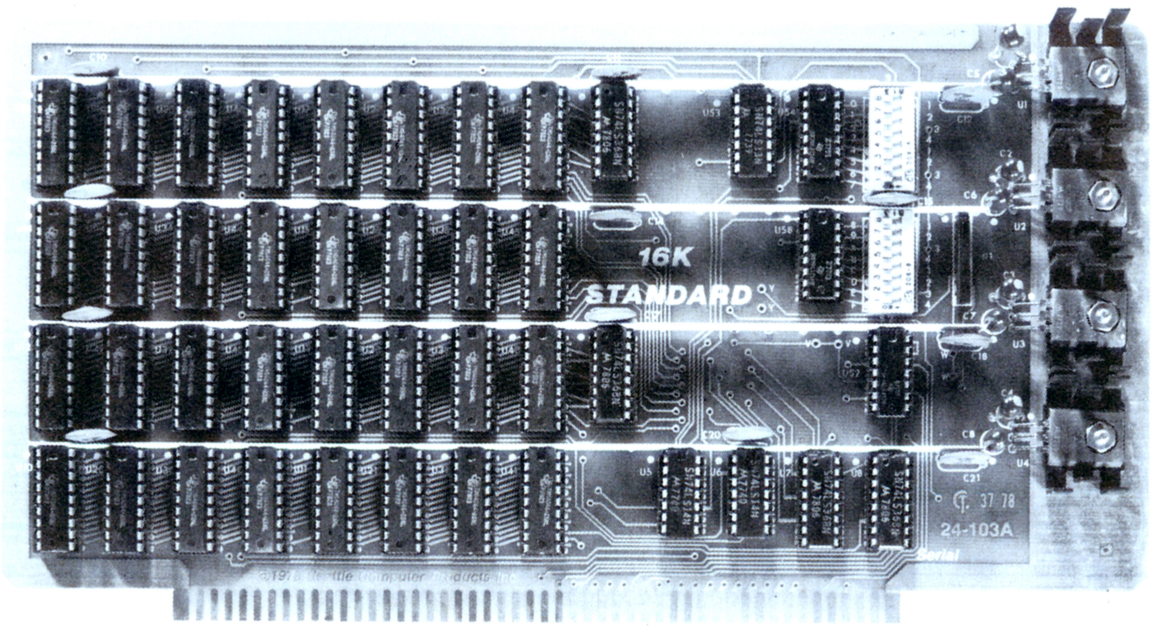

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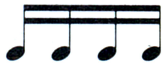
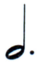
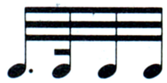
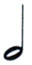
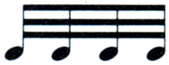
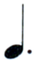
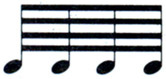
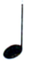
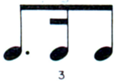
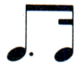
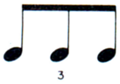
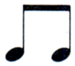
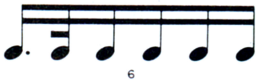
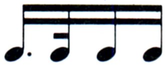
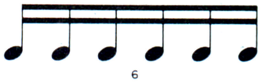
Whole	20160		Sixteenth	1260	
Dotted Half	15120		Dotted Thirty-second	945	
Half	10080		Thirty-second	630	
Quarter	5040		Sixty-fourth	315	
Dotted Quarter	7560		Triplet with dotted eighth	2520	
Dotted Eighth	3780		Triplet	1680	
Eighth	2520		Sextuplet with dotted sixteenth	1260	
Dotted Sixteenth	1890		Sextuplet	840	

Others: Fifth 1008, Seventh 720, Ninth 560, Tenth 504, Eleventh 458, Twelfth 420, Thirteenth 387, Fourteenth 360, Fifteenth 336.

Table 5: *Additional musical symbols.*

the measure. This is stored in the character array of the score area.

3. The Line Length Problem

With different sized measures, how do you determine the number of measures that will fit on each line, thus assuring that the bar lines at the end of each line are aligned? The difficulty of this problem is increased by the fact that not all of the space in a line is used. Each line of music starts with a clef, key signature, and time signature. Every bar line of every measure is bounded by empty space. (Refer to figure 5.) All of these spaces must be accounted for in determining the number of measures that can fit on each line.

Assume that the total length of the line in virtual space is LLINE. The first part of that space must be allocated to the clef and signatures; this will be called LWASTE. The total usable virtual space, LUSABLE, is then equal to LLINE−LWASTE. The wasted space around each measure will be called LMSRWST. If N measures are on the line, then N×LMSRWST space has been wasted in these measures. Now suppose that you are positioned at the first measure that will go on the line. You know the virtual lengths of this measure and all that follow. Denote the sum of the lengths of these first N measures as SUMN. The problem is then to find the largest N such that:

$$LUSABLE \geq SUMN + N \times LMSRWST$$

This says that you want to find the greatest number of measures that can be put on the line before going past the end of the line. In general, the measures will not fit perfectly on the line; therefore there will be excess space at the end. This excess must be distributed equally among the measures, and to do this you must find a scaling factor to transform each X coordinate of the measure into a new coordinate. This scaling factor can be easily determined. Let EXCESS be the excess space at the end of the line. It is equal to LUSABLE − SUMN − N × LMSRWST. The scaling factor then is simply LUSABLE/(LUSABLE − EXCESS). The solution to the line length problem is shown in algorithmic form in listing 1.

Beaming

Before this problem can be formulated I will review some of the questions that must be answered when writing music on the page. These are various conventions used for writing music. The following lists a few of these problems.

Stems Up or Down?

You must first decide if a group of eighth or sixteenth notes will be underbeamed or overbeamed (ie: whether the ligature is placed at the top or bottom of the note stems which point up or down, respectively). The easiest solution to this problem consists in finding the maximum note displacement from the center line of the staff and then drawing the note stems in that direction. There are several exceptional cases for this simple algorithm. For example, if the previous group of notes was underbeamed and the maximum displacement of the next group is above the middle line of the staff (but not by much), the score will read easier if the group is underbeamed rather than overbeamed.

Determining Beam Inclination

Note in figure 7 that the ligature inclination of beaming groups is not always the same. To determine the angle of the beam, you must find the height difference between the stems of the maximum note and the minimum note. For each octave of this difference, increase the height of the tilt by one unit. Notice that the tilt can be either up or down. In the following discussion I will talk about one of the four cases: underbeamed and tilting upward. The other three cases are easy modifications to the algorithms.

Determining the Stem Lengths

The length of the stems from the notes depends on several factors. Suppose you have an underbeamed, upward-inclined beaming group. The shortest note stem must be at least a certain minimum length for readability. Once this distance is set, determine the lengths of the stems for the other notes of the beaming group. These distances depend on the location of the note and the angle of the beam. Although the algorithms are quite involved, they basically consist of solving equations to find the intersection point for the lines of the stems and the beam. A complete description of an example with all the equations is given in figure 8.

The algorithms for each of these problems are not difficult, and for the most part they consist of only a few instructions. However, the exceptional cases which make the music more readable are complex and tedious. Given the ad hoc nature of musical notation there seems to be no mechanical way to eliminate these exceptional cases. Let me briefly outline the basic algorithms. Once again, you assume that you have a routine that provides the beaming groups and that you are dealing only with an underbeamed upward-inclined group.

The beam-characteristic algorithm is shown in listing 2.

Next I will discuss how to determine the beaming groups. The basic strategy is to collect notes with flags until one either goes past a beat or encounters a rest. Then output a beaming group, and if a rest is encountered, continue within the beat to collect the remaining notes of the beat. Only in cases of syncopated rhythms will beaming groups cross over a beat. I might add that this is the reason for the strange initialization:

BEATCOUNT =
BEATCOUNT + 5040

in step 2 of the algorithm, for if BEATCOUNT comes back negative from step 4, a beat has been crossed over. The algorithm is shown in listing 3.

Symbol Problems

Several ways are presented for routines that draw the notes and symbols on the screen. You must keep in mind that the eventual size of the symbols is left to the discretion of the user, and the program must therefore allow for scaling. Scaling sometimes distorts characters, so the editor must have procedures to keep this distortion within a readable limit. I found that for symbols consisting mostly of straight lines, simply storing a set of relative points and drawing lines between them is sufficient. For symbols that are curves, such as the G clef, a better approach is to use a spline-fitting routine to draw the symbol.

Listing 1: *Solution to the line-length problem in algorithmic form.*

```
1. LUSABLE = LLINE − LWASTE
2. N=1      SUMN=Virtual length of first measure
3. VALUE=SUMN+N×LMSRWST
   IF LUSABLE<VALUE THEN GO TO 4
   N = N +1
   SUMN = SUMN + VALUE of virtual length of Nth measure
   GO TO 3
4. EXCESS = LUSABLE − VALUE
   LSCALE = LUSABLE / (LUSABLE − EXCESS)
5. Store scale into the scale portion of the line array for future use when displaying the
   measure.
```

Listing 2: *Algorithm used to determine whether a group of notes should be under or overbeamed.*

```
1. Find the minimum note in the beaming group. MINX, MINY
   Find the maximum note in the beaming group. MAXX, MAXY
   Let OCTAVE be the height of an octave.
   Let MID be the height of the middle note of the staff.
   Let STEM be the minimum length of a stem.
   Let LENGTH be the virtual length of the beaming group.
2. IF (MAX − MID) ≥ (MID − MIN) then overbeam, ELSE underbeam.
   Assume underbeam.
3. TILT = (MAX − MIN) / OCTAVE (integer division)
4. For each note in beaming group:
   Get coordinates into NOTEX, NOTEY
   M = TILT / LENGTH
   B = (MINY − STEM) − MINX × M
   The height of the stem for this note is then equal to NOTEY − M × NOTEX − B.
```

Listing 3: *Algorithm to determine the beaming groups.*

```
1. BEATCOUNT = 0
   MEASURECOUNT = Number of beats to a measure times 5040.
2. BEATCOUNT = BEATCOUNT + 5040
   IF MEASURE ≤ 0     GO TO 5
3. Get value of next note into NOTEVAL
   BEATCOUNT = BEATCOUNT − NOTEVAL
   MEASURECOUNT = MEASURECOUNT − NOTEVAL
4. IF BEATCOUNT ≤ 0 THEN output group and GO TO 2.
   IF encountered a rest THEN output group and go to 3
5. Finished with measure, either continue or stop.
```

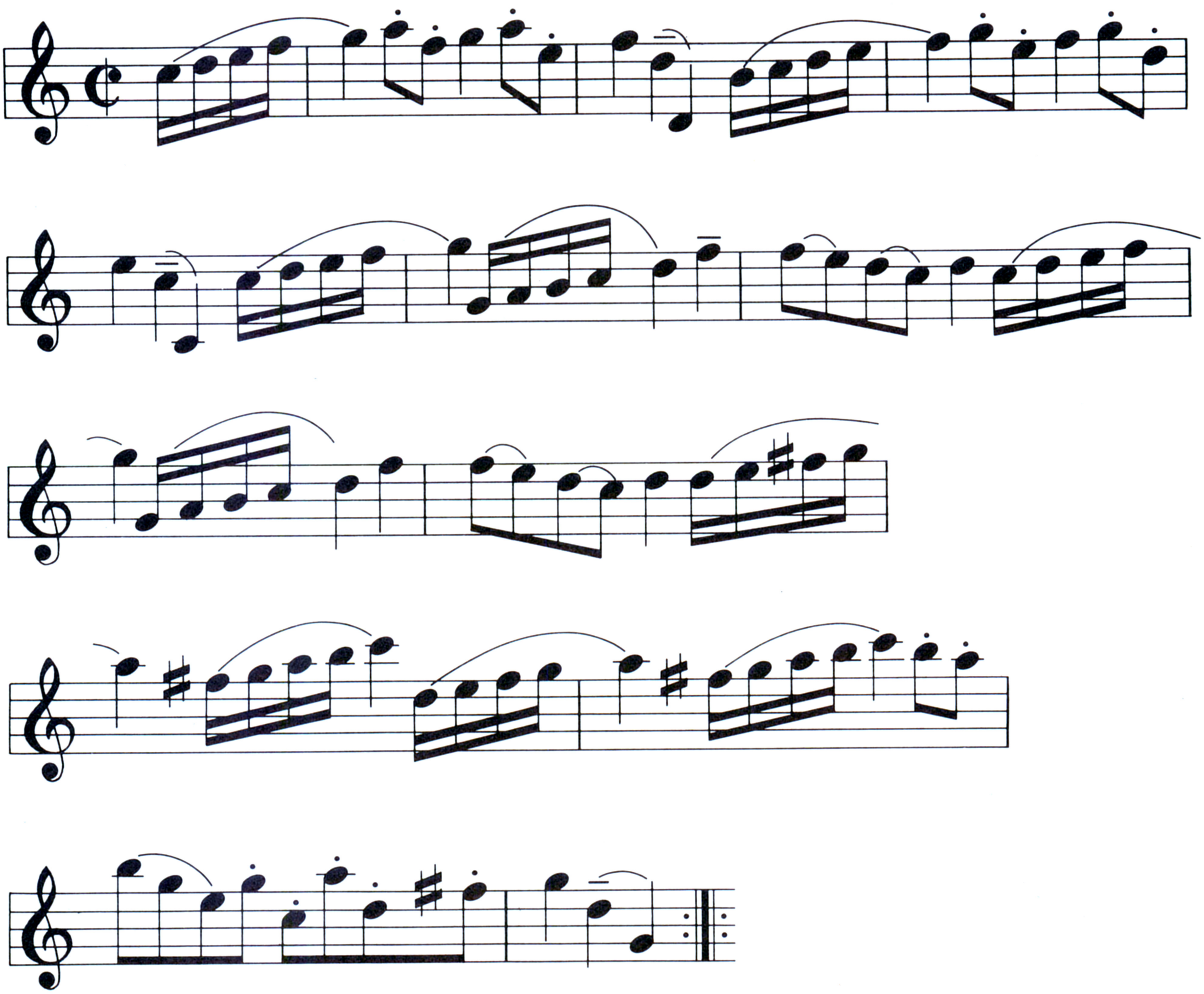


Figure 7: *Sample of a musical score, in this case part of a bourrée by J S Bach. Note the difference in note spacing and in angles of beams.*

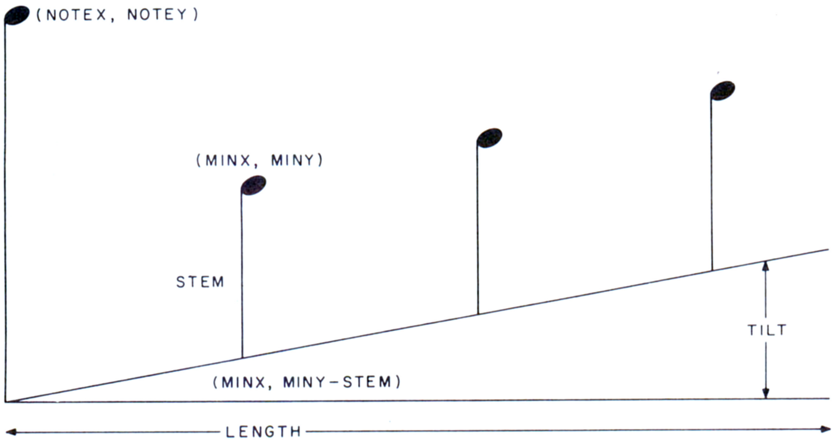


Figure 8: *Calculating the equation of the line segment forming a beam. The standard slope intercept equation $Y = mX + b$ is used. We know that the slope is $M = TILT/LENGTH$, and that the value of one point on the line is (MINX, MINY−STEM). Fitting this to the equation of the line, we can find $b = (MINY-STEM)-M \times MINX$. The heights for all the other stems can then be calculated. For each note, put the X and Y coordinates in NOTEX and NOTEY. The height for this stem is then $HEIGHT = NOTEY-M \times NOTEX-b$.*

Although this requires much more computation time on the computer, it does produce an aesthetically pleasing symbol and allows the user to fine-tune the form of the symbol by simply moving a few of the interpolation points.

Other Points

Now that the basic design of the editor has been presented, I will discuss some of the finer points of the design.

Patterns and Sequences

Although the input format is satisfactory for most music, the use of the current template becomes taxing, if not impossible, when creating a score of complex music. There is no facility that allows the user to input complex rhythms. In order to provide this ability, the concept of a pattern

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Will the growth continue throughout the 1980s and beyond?	☐	☐	☐
COMPANY HISTORY AND REPUTATION *You can tell a lot about a firm by its track record:*			
Is the company recognized and respected in the industry?	☐	☐	☐
Have sales and profits increased at a steady rate?	☐	☐	☐
Is it known for its technological innovations?	☐	☐	☐
Are its employees motivated and well rewarded?	☐	☐	☐
Does the company seek technological employees on a permanent, ongoing basis?	☐	☐	☐
WORKING CONDITIONS AND ENVIRONMENT *Look for good people, team spirit, and top-notch facilities:*			
Is the atmosphere one of loyalty, pride, and achievement?	☐	☐	☐
Do employees welcome the challenge of difficult assignments?	☐	☐	☐
Are creativity and independent thinking encouraged?	☐	☐	☐
Are the company's engineering goals clear-cut and attainable?	☐	☐	☐
THE COMPANY LOCATION *Relocation is a big professional and personal commitment.*			
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Are there major universities and other technological resources nearby?	☐	☐	☐
Will the company assist me in relocating?	☐	☐	☐
Can I provide my family a comfortable lifestyle in this area?	☐	☐	☐
Are there cultural and entertainment opportunities?	☐	☐	☐
Is there a variety of recreational and leisuretime activities?	☐	☐	☐
Are the climate and surroundings pleasant?	☐	☐	☐
PERSONAL AND PROFESSIONAL GROWTH *Job satisfaction means more than just a paycheck:*			
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Will I be working and interacting with other talented professionals in my field?	☐	☐	☐
Will my accomplishments be acknowledged, appreciated, rewarded?	☐	☐	☐
Will I be encouraged to seek more challenge and responsibility?	☐	☐	☐
Will the company pay for advanced training in technology and management?	☐	☐	☐
Can I pursue my own career goals within the company framework?	☐	☐	☐
THE LONG RANGE PICTURE *Where will you be professionally in 5 years?...in 10 years?*			
Are there plenty of opportunities for rapid advancement within the company?	☐	☐	☐
Does the company encourage engineers to assume positions of authority?	☐	☐	☐
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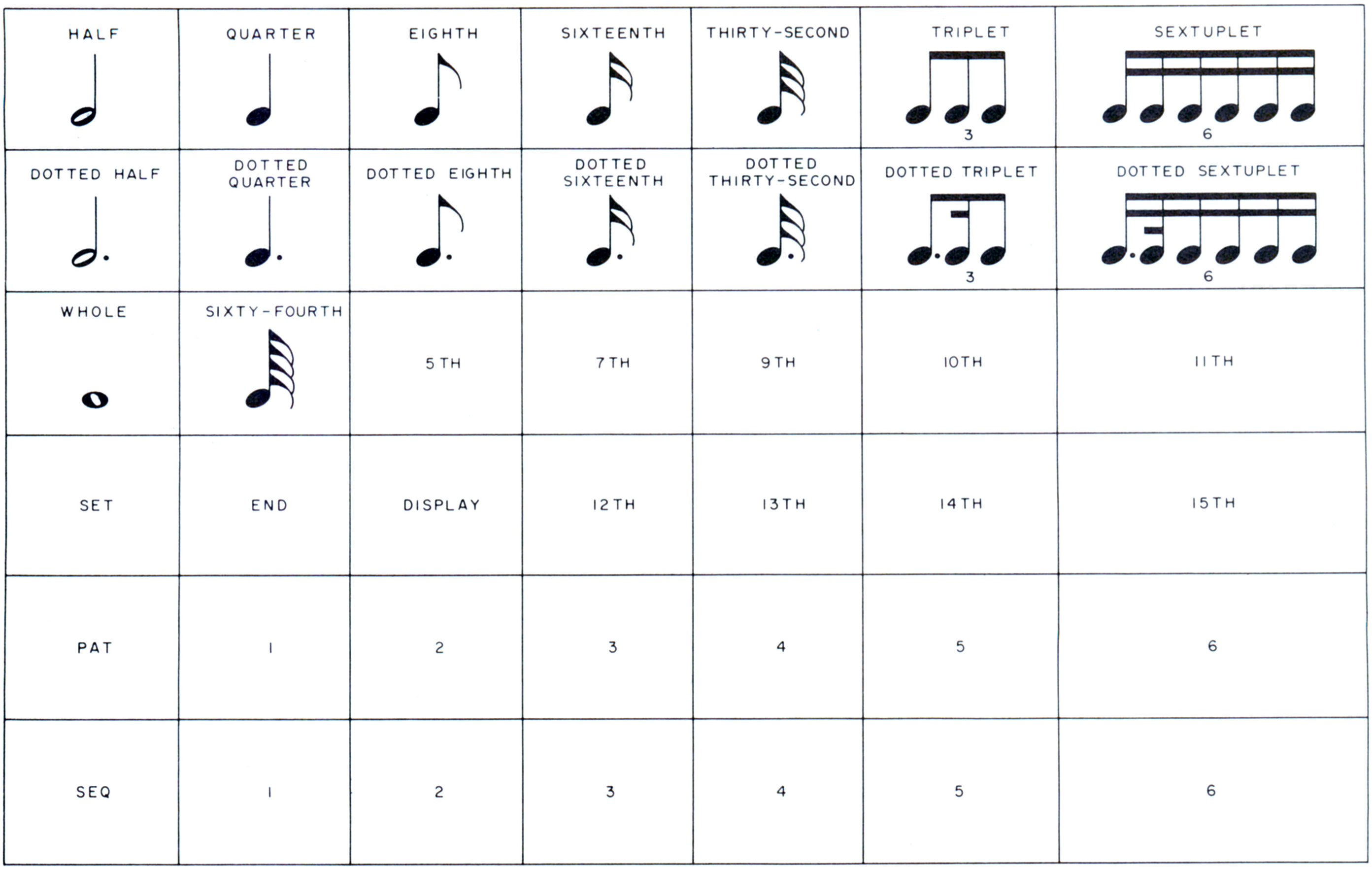

HALF	QUARTER	EIGHTH	SIXTEENTH	THIRTY-SECOND	TRIPLET 3	SEXTUPLET 6
DOTTED HALF	DOTTED QUARTER	DOTTED EIGHTH	DOTTED SIXTEENTH	DOTTED THIRTY-SECOND	DOTTED TRIPLET 3	DOTTED SEXTUPLET 6
WHOLE	SIXTY-FOURTH	5TH	7TH	9TH	10TH	11TH
SET	END	DISPLAY	12TH	13TH	14TH	15TH
PAT	1	2	3	4	5	6
SEQ	1	2	3	4	5	6

Figure 9: *Extensions to the musical template for more advanced editing.*

of rhythm is created. Here the user can establish any rhythmic pattern with a code number. When this code number is touched on the template, the interface program organizes the notes which are entered after it according to that rhythm. The template must now have more fields on it to accommodate this ability, and the interface program must be expanded to perform these computations. The extensions to the template are shown in figure 9. In order to create a rhythmic pattern the user must issue the following commands:

1. Push SET and PAT. This informs the interface program that a pattern is to be created.
2. Push a number on the PAT row. This will be the number of the pattern, and any existing pattern with this number is overwritten.
3. Push the series of note values which determines the pattern.
4. Push END. This signifies the end of the pattern.

To use the pattern the user issues the following commands:

1. Push the number of the pattern.
2. Push the pen onto the correct pitch positions on the staff, preceding them with any attached symbols such as sharps, dots, slurs, etc. Note that the order of the notes and symbols is now important, but the X locations on the staff are immaterial.

The end of the pattern occurs when the number of notes of the pattern is pushed onto the screen. If more notes are entered before another pattern number is pushed, the interface program issues a warning to the user signifying that the pattern is ended. If an insufficient number of notes is entered before another command is issued, the user is warned and the incomplete input is discarded.

A sequence, as used here, is simply a series of patterns. Suppose that sequence 1 consists of the patterns 2, 5, 1. The use of sequence 1 will cause the notes pressed to follow the rhythm of pattern 2. When all of its notes are used up, it will follow the rhythm of pattern 5, and when that is finished, it will follow pattern 1. Setting a sequence is similar to the setting of a pattern. The steps are:

1. Push SET and SEQ.
2. Push a number in the SEQ row. This is the sequence number.
3. Push a series of numbers in the PAT or SEQ row.
4. Push END.

Sequences can cross over measures and can consist of other sequences. To clarify these concepts, input the music in figure 7, using patterns and sequences. There are many ways to input that section of score. Break up the rhythms into their smallest components and then form sequences from them. Thus, three patterns are defined first: one consisting of a quarter note only, the other of two eighth notes, and the last of four sixteenth notes. The following commands do this:

1. Push SET, PAT, and 1.
2. Push QUARTER.
3. Push END.

4. Push SET, PAT, and 2.
5. Push EIGHTH twice.
6. Push END.

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Software for most popular 8080/Z80* computer disk systems including **NORTH STAR, iCOM, MICROPOLIS, DYNABYTE DB8/2 & DB8/4, EXIDY SORCERER, SD SYSTEMS, ALTAIR, VECTOR MZ, MECA, 8" IBM, HEATH H17 & H89, HELIOS, IMSAI VDP42 & 44, REX, NYLAC, INTERTEC SUPER-BRAIN, VISTA V80** and **V200, TRS-80* MODEL I** and **MODEL II, ALTOS, OHIO SCIENTIFIC, DIGI-LOG, KONTRON PS180, IMS 5000 DISKETTE** formats and **CSSN BACKUP** cartridge tapes.

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Software with Manual / Manual Alone

☐ **CP/M* FLOPPY DISK OPERATING SYSTEM** — Digital Research's operating system configured for many popular micro-computers and disk systems:

System	Version	Price
North Star Single Density	1.4	**145/25** v
North Star Double Density	1.4	**145/25**
North Star Double/Quad	2.x	**170/25**
iCOM Micro-Disk 2411	1.4	**145/25**
iCOM 3712	1.4	**170/25** v*
iCOM 3812	1.4	**170/25** *
Mits 3202/Altair 8800	1.4	**145/25**
Heath H8 + H17	1.4	**145/25** Ⓜ
Heath H89	1.4	**145/25** Ⓜ
TRS-80 Model I	1.4	**145/25** Ⓜ
TRS-80 Model II	2.x	**170/25**
Processor Technology Helios II	1.4	**145/25**
Cromemco System 3	1.4	**145/25**
Intel MDS Single Density	1.4	**145/25**
Intel MDS Single Density	2.x	**170/25**
Intel MDS 800 Double Density	2.x	**200/25**
Intel MDS 230 Double Density	2.x	**200/25**
Micropolis Mod I	1.4	**145/25** v
Micropolis Mod II	1.4	**145/25** v

The following configurations are scheduled for release during the first half of 1980:

System	Version	Price
North Star Double/Quad + Corvus	2.x	**250/25**
North Star Horizon HD-1	2.x	**250/25**
Ohio Scientific C3	2.x	**200/25**
Ohio Scientific C3-B	2.x	**250/25**
Ohio Scientific C3-C	2.x	**250/25**
Micropolis Mod II	2.x	**200/25**
Mostek MDX STD Bus System	2.x	**350/25** **
iCOM 3812	2.x	**225/25** *
iCOM 4511/Pertec D3000	2.x	**375/25** * +
TRS-80 Model II + Corvus	2.x	**250/25**

*Software consists of the operating system, text editor, assembler, debugger and other utilities for file management and system maintenance. Complete set of Digital Research's documentation and additional implementation notes included. Systems marked * and ** include firmware on 2708 and 2716. Systems marked + include 5440 media charge. Systems marked Ⓜ require the special Ⓜ versions of software in this catalog. Systems marked v have minor variants available to suit console interface of system. Call or write for full list of options.*

☐ **MP/M*** — Intel MDS single density only (Documentation includes CP/M 2.0 manuals) .... **$300/$50**

☐ Ⓜ **Z80 DEVELOPMENT PACKAGE** — Consists of: (1) disk file line editor, with global inter and intra-line facilities; (2) Z80 relocating assembler, Zilog/Mostek mnemonics, conditional assembly and cross reference table capabilities; (3) linking loader producing absolute Intel hex disk file .... **$95/$20**

☐ Ⓜ **ZDT** — Z80 Monitor Debugger to break and examine registers with standard Zilog/Mostek mnemonic disassembly displays. $35 when ordered with Z80 Development Package .... **$50/$10**

☐ **XASM-68** — Non-macro cross-assembler with nested conditionals and full range of pseudo operations. Assembles from standard Motorola MC6800 mnemonics to Intel hex .... **$200/$25**

☐ **XASM-65** — As XASM-68 for MOS Technology MCS-6500 series mnemonics .... **$200/$25**

☐ **DISTEL** — Disk based disassembler to Intel 8080 or TDL/Xitan Z80 source code, listing and cross reference files. Intel or TDL/Xitan pseudo ops optional. Runs on 8080 .... **$65/$10**

☐ Ⓜ **DISILOG** — As DISTEL to Zilog/Mostek mnemonic files. Runs on Z80 only .... **$65/$10**

☐ Ⓧ **SMAL/80** Structured Macro Assembler Language — Package of powerful general purpose text macro processor and SMAL structured language compiler. SMAL is an assembler language with IF-THEN-ELSE, LOOP-REPEAT-WHILE, DO-END, BEGIN-END constructs .... **$75/$15**

☐ Ⓧ **tiny C** — Interactive interpretive system for teaching structured programming techniques. Manual includes full source listings .... **$105/$40**

New Features

☐ Ⓜ Ⓘ **BDS C COMPILER** — Supports most features of language, including Structures, Arrays, Pointers, recursive function evaluation, overlays. Includes linking loader, library manager, and library containing general purpose, file I/O, and floating point functions. Lacks initializers, statics, floats and longs. Documentation includes "The C PROGRAMMING LANGUAGE" by Kernighan and Ritchie .... **$125/$20**

☐ Ⓛ Ⓧ **WHITESMITHS C COMPILER** — The ultimate in systems software tools. Produces faster code than a pseudo-code Pascal with more extensive facilities. Conforms to the full UNIX* Version 7 C language, described by Kernighan and Ritchie, and makes available over 75 functions for performing I/O, string manipulation and storage allocation. Linkable to Microsoft REL files. Requires 60K CP/M .... **$630/$30**

Everything on #12 runs on 64K TRS-80 Model II

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MICROSOFT

☐ Ⓛ Ⓧ Ⓜ Ⓧ **BASIC-80** — Disk Extended BASIC, ANSI compatible with long variable names, WHILE/WEND, chaining, variable length file records .... **$325/$25**

☐ Ⓛ Ⓜ **BASIC COMPILER** — Language compatible with BASIC-80 and 3-10 times faster execution. Produces standard Microsoft relocatable binary output. Includes MACRO-80. Also linkable to FORTRAN-80 or COBOL-80 code modules .... **$350/$25**

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☐ Ⓛ Ⓜ **COBOL-80** — Level 1 ANSI '74 standard COBOL plus most of Level 2. Full sequential, relative, and indexed file support with variable file names. STRING, UNSTRING, COMPUTE, VARYING/UNTIL, EXTEND, CALL, COPY, SEARCH, 3-dimensional arrays, compound and abbreviated conditions, nested IF. Powerful interactive screen-handling extensions. Includes compatible assembler, linking loader, and relocatable library manager as described under MACRO-80 .... **$700/$25**

☐ Ⓛ Ⓜ **MACRO-80** — 8080/Z80 Macro Assembler. Intel and Zilog mnemonics supported. Relocatable linkable output. Loader, Library Manager and Cross Reference List utilities included .... **$149/$15**

☐ Ⓛ **XMACRO-86** — 8086 cross assembler. All Macro and utility features of MACRO-80 package. Mnemonics slightly modified from Intel ASM86. Compatibility data sheet available .... **$275/$25**

☐ Ⓛ **EDIT-80** — Very fast random access text editor for text with or without line numbers. Global and intra-line commands supported. File compare utility included. .... **$89/$15**

Price Slashed

☐ Ⓘ **PASCAL/M*** — Compiler generates P code from extended language, implementation of standard PASCAL. Supports overlay structure through additional procedure calls and the SEGMENT procedure type. Provides convenient string handling capability with the added variable type STRING. Untyped files allow memory image I/O. Requires 56K CP/M .... **$150/$20**

☐ Ⓘ **PASCAL/Z** — Z80 native code PASCAL compiler. Produces optimized, ROMable re-entrant code. All interfacing to CP/M is through the support library. The package includes compiler, Microsoft Compatible relocating assembler and linker, and source for all library modules. Variant records, strings and direct I/O are supported. Requires 56K CP/M and Z80 CPU. .... **$395/$25**

New Version New Features

☐ Ⓜ Ⓧ **PASCAL/MT** — Subset of standard PASCAL. Generates ROMable 8080 machine code. Symbolic debugger included. Supports interrupt procedures, CP/M file I/O and assembly language interface. Real variables can be BCD, software floating point, or AMD 9511 hardware floating point. Version 3 includes Enumeration and Record data types. Manual explains BASIC to PASCAL conversion. Source for the runtime package requires Digital Research's MAC. Requires 32K .... **$250/$30**

☐ **ALGOL-60** — Powerful block-structured language compiler featuring economical run-time dynamic allocation of memory. Very compact (24K total RAM) system implementing almost all Algol 60 report features plus many powerful extensions including string handling direct disk address I/O etc. Requires Z80 CPU .... **$199/$20**

☐ Ⓜ **CBASIC-2** Disk Extended BASIC — Non-interactive BASIC with pseudo-code compiler and run-time interpreter. Supports full file control, chaining, integer and extended precision variables, etc. ..... **$120/$15**

MICRO FOCUS

☐ Ⓛ **STANDARD CIS COBOL** — ANSI '74 COBOL standard compiler fully validated by U.S. Navy tests to ANSI level 1. Supports many features to level 2 including dynamic loading of COBOL modules and a full*ISAM file facility. Also, program segmentation, interactive debug and powerful interactive extensions to support protected and unprotected CRT screen formatting from COBOL programs used with any dumb terminal .... **$850/$50**

☐ Ⓛ **FORMS 2** — CRT screen editor. Output is COBOL data descriptions for copying into CIS COBOL programs. Automatically creates a query and update program of indexed files using CRT protected and unprotected screen formats. No programming experience needed. Output program directly compiled by CIS COBOL (standard) .... **$200/$20**

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☐ Ⓛ **KISS** — Keyed Index Sequential Search. Offers complete Multi-Keyed Index Sequential and Direct Access file management. Includes built-in utility functions for 16 or 32 bit arithmetic, string/integer conversion and string compare. Delivered as a relocatable linkable module in Microsoft format for use with FORTRAN-80 or COBOL-80, etc. .... **$335/$23**

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☐ Ⓛ **KBASIC** — Microsoft Disk Extended BASIC with all KISS facilities, integrated by implementation of nine additional commands in language. Package includes KISS. REL as described above, and a sample mail list program .... **$585/$45**
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☐ **XYBASIC** Interactive Process Control BASIC — Full disk BASIC features plus unique commands to handle bytes, rotate and shift, and to test and set bits. Available in Integer, Extended and ROMable versions.
Integer Disk or Integer ROMable .... **$295/$25**
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☐ Ⓜ **BASIC UTILITY DISK** — Consists of: (1) CRUNCH-14 — Compacting utility to reduce the size and increase the speed of programs in Microsoft BASIC and TRS-80 BASIC. (2) DPFUN — Double precision subroutines for computing nineteen transcendental functions including square root, natural log, log base 10, sin, arc sin, hyperbolic sin, hyperbolic arc sin, etc. Furnished in source on diskette and documentation ... **$50/$35**

☐ Ⓜ **STRING/80** — Character string handling plus routines for direct CP/M BDOS calls from FORTRAN and other compatible Microsoft languages. The utility library contains routines that enable programs to chain to a COM file, retrieve command line parameters, and search file directories with full wild card facilities. Supplied as linkable modules in Microsoft format. .... **$95/$20**

STRING/80 source code available separately **$295/n.a.**

☐ **THE STRING BIT** — FORTRAN character string handling. Routines to find, fill, pack, move, separate, concatenate and compare character strings. This package completely eliminates the problems associated with character string handling in FORTRAN. Supplied with source .... **$65/$15**

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☐ Ⓜ **VSORT** — Versatile sort/merge system for fixed length records with fixed or variable length fields. VSORT can be used as a stand-alone package or loaded and called as a subroutine from CBASIC-2. When used as a subroutine, VSORT maximizes the use of buffer space by saving the TPA on disk and restoring it on completion of sorting. Records may be up to 255 bytes long with a maximum of 5 fields. Upper/lower case translation and numeric fields supported. .... **$175/$20**

☐ **CPM/374X** — Has full range of functions to create or re-name an IBM 3741 volume, display directory information and edit the data set contents. Provides full file transfer facilities between 3741 volume data sets and CP/M files .... **$195/$10**

☐ Ⓜ **BSTAM** — Utility to link one computer to another also equipped with BSTAM. Allows file transfers at full data speed (no conversion to hex), with CRC block control check for very reliable error detection and automatic retry. We use it! It's great! Full wildcard expansion to send ★.COM, etc. 9600 baud with wire. 300 baud with phone connection. **Both** ends need one. Standard and Ⓜ versions can talk to one another. .... **$150/$5**

☐ **WHATSIT?*** Interactive data-base system using associative tags to retrieve information by subject. Hashing and random access used for fast response. Requires CBASIC-2 .... **$175/$25**

Lower Price!

☐ Ⓜ † **SELECTOR III-C2** — Data Base Processor to create and maintain multi Key data bases. Prints formatted sorted reports with numerical summaries or mailing labels. Comes with sample applications, including Sales Activity, Inventory, Payables, Receivables, Check Register, and Client/Patient Appointments, etc. Requires CBASIC-2. Supplied in source ... **$295/$20**

☐ **GLECTOR** — General Ledger option to SELECTOR III-C2. Interactive system provides for customized COA. Unique chart of transaction types insure proper double entry bookkeeping. Generates balance sheets, P&L statements and journals. Two year record allows for statement of changes in financial position report. Supplied in source. Requires SELECTOR III-C2, CBASIC-2 and 52K system .... **$250/$25**

NEW

☐ Ⓜ **CBS** — Configurable Business System is a comprehensive set of programs for defining custom data files and application systems without using programming language such as BASIC, FORTRAN, etc. Multiple key fields for each data file are supported. Set-up program customizes system to user's CRT and printer. Provides fast and easy interactive data entry and retrieval **with transaction processing.** Report generator program does complex calculations with stored and derived data, record selection with multiple criteria, and custom formats. Sample inventory and mailing list systems included. **No support language required** .... **$295/$25**

Prices and specifications subject to change without notice.

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MICRO DATA BASE SYSTEMS

☐ **HDBS** — Hierarchical Data Base System. CODASYL oriented with FILEs, SETs, RECORDs and ITEMs which are all user defined. ADD, DELETE, UPDATE, SEARCH, and TRAVERSE commands supported. SET ordering is sorted, FIFO, LIFO, next or prior. One to many set relationship supported. Read/Write protection at the FILE level. Supports FILEs which extend over multiple floppy or hard disk devices.

☐ **MDBS** — Micro Data Base System. Full network data base with all features of HDBS plus multi-level Read/Write protection for FILE, SET, RECORD and ITEM. Explicit representation of one to one, one to many, many to many, and many to one SET relationships. Supports multiple owner and multiple record types within SETs. HDBS files are fully compatible.

☐ **MDBS-DRS** — MDBS with Dynamic Restructuring System option which allows altering MDBS data bases when new ITEMs, RECORDs, or SETs are needed without changing existing data.

HDBS-Z80 version .... **$250/$40**
MDBS-Z80 version .... **$750/$40**
MDBS-DRS-Z80 version .... **$850/$50**
8080 Version available at $75. extra.

When ordering, specify one of the languages listed below.

NOTE

HDBS and MDBS manuals purchased alone come without specific language interface manuals. Manuals are available for the following Microsoft languages: 1) MBASIC 4.51, 2) BASIC-80, 5.0, 3) Compiled BASIC-80 or FORTRAN-80, 4) COBOL-80, 5) MACRO-80 .... **$NA/$10**

all Micropro prices are discounted!

MICROPRO

☐ Ⓛ **SUPER-SORT I** — Sort, merge, extract utility as absolute executable program or linkable module in Microsoft format. Sorts fixed or variable records with data in binary, BCD, Packed Decimal, EBCDIC, ASCII, floating & fixed point, exponential, field justified, etc. Even variable number of fields per record! . **$225/$25**

☐ Ⓛ **SUPER-SORT II** — Above available as absolute program only .... **$175/$25**

☐ Ⓛ **SUPER-SORT III** — As II without SELECT/EXCLUDE .... **$125/$25**

☐ Ⓛ **WORD-STAR** — Menu driven visual word processing system for use with standard terminals. Text formatting performed on screen. Facilities for text paginate, page number, justify, center and underscore. User can print one document while simultaneously editing a second. Edit facilities include global search and replace, Read/Write to other text files, block move, etc. Requires CRT terminal with addressable cursor positioning .... **$445/$40**

☐ **WORD-STAR Customization Notes** — For sophisticated users who do not have one of the many standard terminal or printer configurations in the distribution version of WORD-STAR .... **NA/$95**

☐ Ⓛ **WORD-MASTER** Text Editor — In one mode has superset of CP/M's ED commands including global searching and replacing, forwards and backwards in file in video mode, provides full screen editor for users with serial addressable-cursor terminal .... **$125/$25**

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☐ Ⓜ **POLYVUE/80** — Full screen editor for any CRT with XY cursor positioning. Includes vertical and horizontal scrolling, interactive search and replace, automatic text wrap around for word processing, operations for manipulating blocks of text, and comprehensive 70 page manual .... **$135/$15**

☐ Ⓜ **POLYTEXT/80** — Text formatter for word processing applications. Justifies and paginates source text files. Will generate form letters with custom fields and conditional processing. Support for Daisy Wheel printers includes variable pitch justification and motion optimization .... **$85/$15**

☐ Ⓜ **TEXTWRITER III** — Text formatter to justify and paginate letters and other documents. Special features include insertion of text during execution from other disk files or console, permitting recipe documents to be created from linked fragments on other files. Has facilities for sorted index, table of contents and footnote insertions. Ideal for contracts, manuals, etc. Now compatible with Electric Pencil* prepared files. .... **$125/$20**

Now-applications software for Microsoft's BASIC interpreter!

PEACHTREE SOFTWARE

☐ Ⓛ † **GENERAL LEDGER** — Records details of all financial transactions. Generates a balance sheet and an income statement. Flexible and adaptable design for both small businesses and firms performing client writeup services. Produces reports as follows: Trial Balance, Transaction Registers, Balance Sheet, Prior Year Comparative Balance Sheet, Income Statement, Prior Year Comparative Income Statement and Department Income Statements. Interactive with other PEACHTREE accounting packages. Supplied in source code for Microsoft BASIC .... **$990/$30**

☐ Ⓛ † **ACCOUNTS PAYABLE** — Tracks current and aged payables and incorporates a check writing feature. Maintains a complete vendor file with information on purchase orders and discount terms as well as active account status. Produces reports as follows: Open Voucher Report, Accounts Payable Aging Report and Cash Requirements. Provides input to PEACHTREE General Ledger. Supplied in source code for Microsoft. BASIC .... **$990/$30**

☐ Ⓛ † **ACCOUNTS RECEIVABLE** — Generates invoice register and complete monthly statements. Tracks current and aged receivables. Maintains customer file including credit information and account status. The current status of any customer account is instantly available. Produces reports as follows: Aged Accounts Receivable, Invoice Register, Payment and Adjustment Register and Customer Account Status Report. Provides input to PEACHTREE General Ledger. Supplied in source code for Microsoft BASIC .. **$990/$30**

☐ Ⓛ † **PAYROLL** — Prepares payroll for hourly, salaried and commissioned employees. Generates monthly, quarterly and annual returns. Prepares employee W-2's. Includes tables for federal withholding and FICA as well as withholding for all 50 states plus up to 20 cities from pre-computed or user generated tables. Will print checks, Payroll Register, Monthly Summary and Unemployment Tax Report. Provides input to PEACHTREE General Ledger. Supplied in source code for Microsoft BASIC .... **$990/$30**

☐ Ⓛ † **INVENTORY** — Maintains detailed information on each inventory item including part number, description, unit of measure, vendor and reorder data, item activity and complete information on current item costs, pricing and sales. Produces reports as follows: Physical Inventory Worksheet, Inventory Price List, Departmental Summary Report, Inventory Status Report, The Reorder Report and the Period-to-Date and Year-to-Date reports. Supplied in source code for Microsoft BASIC .... **$1,190/$30**

☐ Ⓛ † **MAILING ADDRESS** — Keeps track of name and address information and allows the selective printing of this information in the form of mailing lists or address labels. Allows the user to tailor the system to his own particular requirements. User-defined format and print-out system uses a special format file which tells programs how to print the mailing list or address labels. Standard format files are included with system. Automatic sorting of data uses indexed file management routines which allow the name and address information to be sequentially retrieved and printed without file sorting. Supplied in source code for Microsoft BASIC .... **$790/$30**

GRAHAM-DORIAN SOFTWARE SYSTEMS

☐ Ⓛ Ⓜ † **GENERAL LEDGER** — An on-line system; no batching is required. Entries to other GRAHAM-DORIAN accounting packages are automatically posted. User establishes customized C.O.A. Provides transaction register, record of journal entries, trial balances and monthly closings. Keeps 14 month history and provides comparison of current year with previous year. Requires CBASIC-2. Supplied in source ... **$995/$35**

☐ Ⓛ Ⓜ † **ACCOUNTS PAYABLE** — Maintains vendor list and check register. Performs cash flow analysis. Flexible — writes checks to specific vendor for certain invoices or can make partial payments. Automatically posts to GRAHAM-DORIAN General Ledger or runs as stand alone system. Requires CBASIC-2. Supplied in source .... **$995/$35**

☐ Ⓛ Ⓜ † **ACCOUNTS RECEIVABLE** — Creates trial balance reports, prepares statements, ages accounts and records invoices. Provides complete information describing customer payment activity. Receipts can be posted to different ledger accounts. Entries automatically update GRAHAM-DORIAN General Ledger or runs as stand alone system. Requires CBASIC-2. Supplied in source .... **$995/$35**

☐ Ⓛ Ⓜ † **PAYROLL SYSTEM** — Maintains employee master file. Computes payroll withholding for FICA, Federal and State taxes. Prints payroll register, checks, quarterly reports and W-2 forms. Can generate ad hoc reports and employee form letters with mail labels. Requires CBASIC-2. Supplied in source .... **$590/$35**

☐ Ⓛ Ⓜ † **INVENTORY SYSTEM** — Captures stock levels, costs, sources, sales, ages, turnover, markup, etc. Transaction information may be entered for reporting by salesman, type of sale, date of sale, etc. Reports available both for accounting and decision making. Requires CBASIC-2. Supplied in source ... **$590/$35**

☐ Ⓛ Ⓜ † **JOB COSTING** — Designed for general contractors. To be used interactively with other GRAHAM-DORIAN accounting packages for tracking and analysing expenses. User establishes customized cost categories and job phases. Permits comparison of actual versus estimated costs. Automatically updates GRAHAM-DORIAN General Ledger or runs as stand alone system. Requires CBASIC-2. Supplied in source **$995/$35**

Orders must specify disk systems and formats: e.g. North Star single, double or quad density, IBM single or 2D/256, Altair, Helios II, Micropolis Mod I or II, 5¼" soft sector (Micro iCOM/SD Systems Dynabyte), etc.

Prices F.O.B. New York. Shipping, handling and C.O.D. charges extra.

Manual cost applicable against price of subsequent software purchase.

The sale of each proprietary software package conveys a license for use on one system only.

VISA master charge

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☐ Ⓛ Ⓜ † **APARTMENT MANAGEMENT SYSTEM** — Financial management system for receipts and security deposits of apartment projects. Captures data on vacancies, revenues, etc. for annual trend analysis. Daily report shows late rents, vacancy notices, vacancies, income lost through vacancies, etc. Requires CBASIC-2. Supplied in source .... **$590/$35**

☐ Ⓛ Ⓜ † **CASH REGISTER** — Maintains files on daily sales. Files data by sales person and item. Tracks sales, over-rings, refunds, payouts and total net deposits. Requires CBASIC-2. Supplied in source ... **$590/$35**

New Features →

☐ Ⓜ **POSTMASTER** — A comprehensive package for mail list maintenance that is completely menu driven. Features include keyed record extraction and label production. A form letter program is included which provides neat letters on single sheet or continuous forms. Compatible with NAD files. Requires CBASIC-2 .... **$150/$15**

STRUCTURED SYSTEMS GROUP

☐ † **GENERAL LEDGER** — Interactive and flexible system providing proof and report outputs. Customization of COA created interactively. Multiple branch accounting centers. Extensive checking performed at data entry for proof, COA correctness, etc. Journal entries may be batched prior to posting. Closing procedure automatically backs up input files. Now includes Statement of Changes in Financial Position. Requires CBASIC-2 .... **$1250/$25**

☐ † **ACCOUNTS RECEIVABLE** — Open item system with output for internal aged reports and customer-oriented statement and billing purposes. On-Line Enquiry permits information for Customer Service and Credit departments. Interface to General Ledger provided if both systems used. Requires CBASIC-2. .... **$1250/$25**

☐ † **ACCOUNTS PAYABLE** — Provides aged statements of accounts by vendor with check writing for selected invoices. Can be used alone or with General Ledger and/or with NAD. Requires CBASIC-2 .... **$1250/$25**

☐ † **PAYROLL** — Flexible payroll system handles weekly, bi-weekly, semi-monthly and monthly payroll periods. Tips, bonuses, re-imbursements, advances, sick pay, vacation pay, and compensation time are all part of the payroll records. Prints government required periodic reports and will post to multiple SSG General Ledger accounts. Requires CBASIC-2 and 54K of memory .... **$1250/$25**

☐ † **INVENTORY CONTROL SYSTEM** — Performs control functions of adding and depleting stock items, adding new items and deleting old items. Tracks quantity of items on hand, on order and back-ordered. Optional hard copy audit trail is available. Reports include Master Item List, Stock Activity, Stock Valuation and Re-order List. Requires CBASIC-2 **$1250/$25**

☐ † **ANALYST** — Customized data entry and reporting system. User specifies up to 75 data items per record. Interactive data entry, retrieval, and update facility makes information management easy. Sophisticated report generator provides customized reports using selected records with multiple level break-points for summarization. Requires CBASIC-2 .... **$250/$15**

☐ **LETTERIGHT** — Program to create, edit and type letters or other documents. Has facilities to enter, display, delete and move text, with good video screen presentation. Designed to integrate with NAD for form letter mailings. Requires CBASIC-2 .. **$200/$25**

☐ **NAD** Name and Address selection system — interactive mail list creation and maintenance program with output as full reports with reference data or restricted information for mail labels. Transfer system for extraction and transfer of selected records to create new files. Requires CBASIC-2 .... **$100/$20**

☐ **QSORT** — Fast sort/merge program for files with fixed record length, variable field length information. Up to five ascending or descending keys. Full back-up of input files created .... **$100/$20**

★★★★★★★★

CONDIMENTS

☐ **HEAD CLEANING DISKETTE**—Cleans the drive Read/Write head in 30 seconds. Diskette absorbs loose oxide particles, fingerprints, and other foreign particles that might hinder the performance of the drive head. Lasts at least 3 months with daily use. Specify 5" or 8".
NEW →
Single sided .... **$20 each/$55 for 3**
Double sided .... **$25 each/$65 for 3**

☐ **FLIPPY DISK KIT** — Template and instructions to modify single sided 5¼" diskettes for use of second side in single sided drives **$12.50**

☐ **FLOPPY SAVER** — Protection for center holes of 5" and 8" floppy disks. Only 1 needed per diskette. Kit contains centering post, pressure tool and tough 7 mil mylar reinforcing rings for 25 diskettes.
5", Kit **$14.95**
5", Rings only **$7.95**
NEW →
8", Kit **$16.95**
8", Rings only **$8.95**

☐ **PASCAL USER MANUAL AND REPORT** — By Jensen and Wirth. The standard textbook on the language. Recommended for use by Pascal/Z, Pascal/M and Pascal/MT users **$10**

☐ **THE C PROGRAMMING LANGUAGE** — By Kernighan and Ritchie. The standard textbook on the language. Recommended for use by BDS C, tiny C, and Whitesmiths C users **$12**

NEW →

☐ **STRUCTURED MICROPROCESSOR PROGRAMMING** — By the authors of SMAL/80. Covers structured programming, the 8080/8085 instruction set and the SMAL/80 language **$20.00**

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7. Push SET, PAT, and 3.
8. Push SIXTEENTH four times.
9. Push END.

Note that there are now four sequences that can be defined. They are labelled on the score. I will create the commands for the first one only, since the others are similar:

1. Push SET, SEQ, and 1.
2. Push 3,1,2,1,2,1,1,1 on the PAT row.
3. Push END.

The other sequences consist of:

#2 - 3,1,3,1,1,2,2,1
#3 - 3,1,3,1
#4 - 2,2,2,2,2,1,1,1

The different ways of ordering sequences and patterns are numerous. The above score in particular could have been entered in several ways.

Using a scheme like this, any score of music can be entered into the editor. Other schemes could be devised to tailor the input form to the type of music being edited. The only changes to the program, however, would occur in the input-interface program; the main part of the editor would remain unchanged.

Symbols That Cross Over Measures

I have not yet approached the problem of symbols that cross over measures and, thus, over lines and pages. Nor have I discussed the placement of nested slurs or ties and how to draw them on the screen. These problems are complex; their solutions lie in keeping pointers in the character array to the locations where the symbol begins and ends. Any changes to these measures, such as deletion, must also change these pointers — for example, we do not have a beginning of a crescendo with no end. Thus these pointers must again be doubly-linked. Drawing the correct arcs for slurs and ties presents a problem because they can be separated by long distances. A routine must be called when the screen locations are known to fit a curve through these points.

Reformatting

After editing a page, the format of the pages from then on is usually different. If you simply added a character in a measure, the paging will probably remain the same; however, if you add thirty notes to the measure, it is much longer, and might change the number of measures on the line and hence the format of the page. How far this change will carry depends upon the size of the change and the scaling factors of the measures. (If the scaling factors were all 1.0, then any change to a measure would cause a complete repaging of the score.)

Whenever the user wants to display or edit the score, a formatting program must be called to repage the score. This routine must execute the algorithms given previously, which determine the beaming groups of the measures and the measure lengths of all changed measures. It must then determine which measures will go on the lines. It needs to alter the existing paging only as far as the change propagates, but there is no way to predict this in advance. Thus a simple change could cause considerable computation.

Conclusion

I hope that the reader has begun to appreciate the problems involved in creating a text editor for music. What is the utility of such a program? To anyone who has ever tried printing a score of music with india ink, the virtues of an editor with hard-copy facilities are obvious. A number of uses for the program present themselves. For example, very often music written in one key needs to be changed into one of the other keys. This is called *transposition*. A program can easily be written which takes the contents of the character array and performs the transformation.

You might wish to create computer music and display it on the screen. You could write a music-generation program and feed its output to a conversion routine that would convert its output into the format of the editor. If actual sounds were converted into pitches and durations with an electronic device, this could be placed in the editor, and you could see the music that was being played. If several scores by a composer are entered into the program and statistical analysis is performed on them to determine the probabilities of certain patterns of music, the results could, in theory, be used to drive a music-generation program that would simulate the composer's style. This same approach could be applied to music from different historical periods, thus enabling the computer to create a classical symphony or a twelve-tone quartet.■

Editor's note: The data-entry system for musical scores described in this article has a bias toward transcription of scores containing a single melodic line. Other types of musical scores contain elements which are not dealt with here. For instance, music for keyboard instruments, such as the piano, usually contain chords consisting of several notes to be sounded simultaneously. These chords are often written as several note heads sharing a single stem. It would be difficult at best to work with such music using this system. Enhancing the system to handle these elements would be a good project for the ambitious reader. . . . **RSS**

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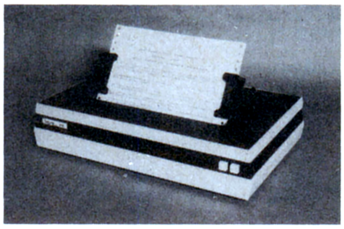

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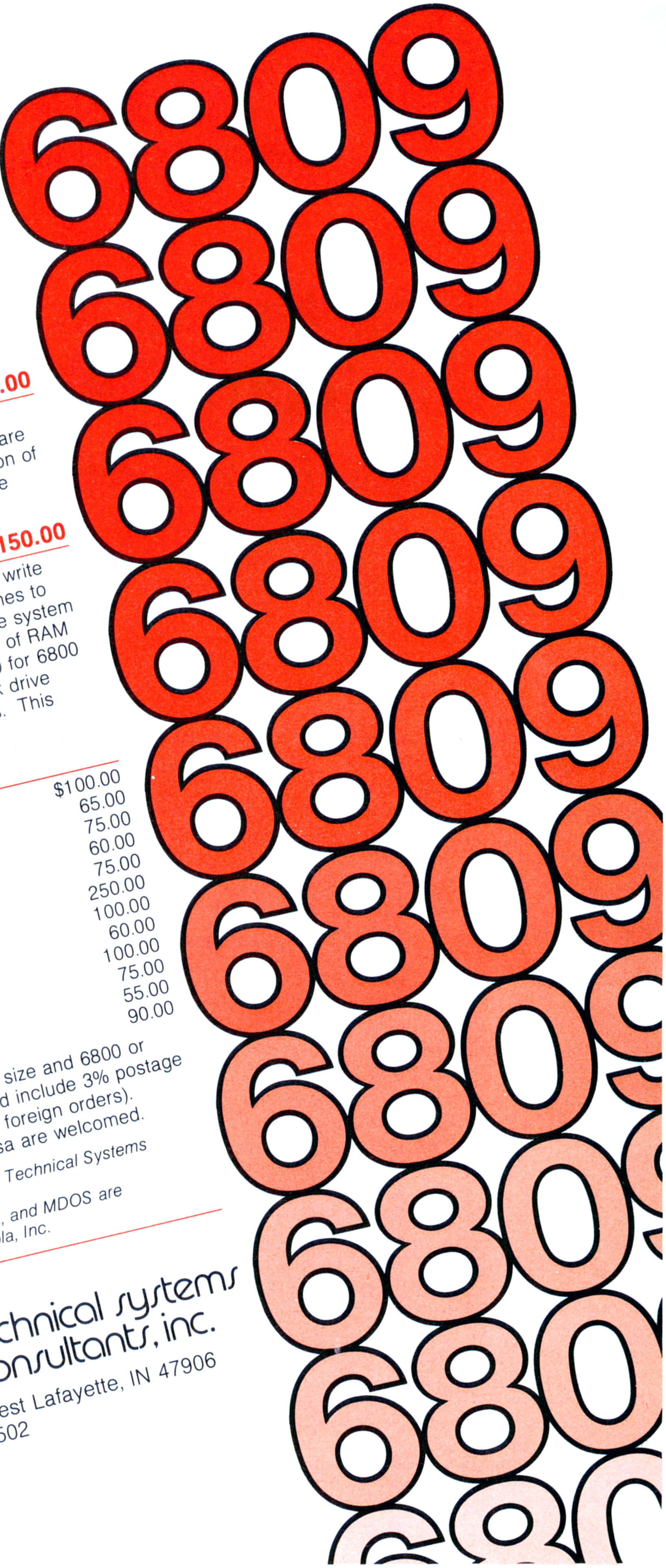

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Using the Computer as a Musician's Amanuensis

Part 2: Going from Keyboard to Printed Score

Jef Raskin
Apple Computer Co
10260 Bandley Dr
Cupertino CA 95014

More Problems with Rhythm and Tempo

The would-be Composer's Aid designer plummets into another pile of programming problems when tempi change. The beat, *sometimes* constant within a piece, may abruptly slow down, as may happen in a reflective refrain in a blues number, or gradually accelerate, as in a Greek folk dance. Changes of tempo present problems that are worse than the problems in transcribing rhythms that we have already seen.

It is not difficult to see that an abrupt change in tempo cannot be detected the instant that it happens, but only after a few notes have been played at the new speed, establishing, as musicians say, the new tempo. This brings up the concept that rhythm does not exist only in relation to the length of individual notes, but exists also in a much larger musical context.

Therefore, a computer (or a human being) cannot notate rhythm in real time (ie: as it happens). The notator must wait and accumulate a significant sample (ie: listen for a while) before making any decision how to write down what has been heard. A computer program that must determine rhythms will most probably have to backtrack through the data, perhaps a number of times, before deciding how to notate the music.

A computer (or a human being) cannot notate rhythm in real time.

Much of the fun in listening to music comes from anticipation of the rhythm; the composer or performer can use rhythmic expectations as a background against which to introduce rhythmic novelties. This is similar to the use of harmonic and melodic "surprises" that cannot be assessed until some time after they have been heard. The fact that we hear music in a context of expectations built on previous experience stands as a sentinel, guarding against the possibility that there is an easy algorithm that might "understand" music on a note-by-note basis.

Further Consequences of Changes of Tempo

A gradual change of tempo is either *accelerando* (getting faster) or *ritardando* (getting slower). In ritardando (very common at the ends of pieces or sections of pieces), how is the computer to tell the difference between a gradual lengthening of the written note values on one hand, and the use of the word "ritardando" along with an actual constant note length, on the other? This is very easy for a human to do, but it is very difficult to tell a computer how we do it.

In many pieces that require this slowing down, there is no notation for a ritardando at all. In these cases, the ritardando is inherent in the nature of the music. The conventional notation is to write the score as if nothing at all happens to the tempo.

This last problem afflicts score-to-performance transforming programs more than it afflicts programs that transform performances to scores. It is one of the symptoms of "soulless" computer performances. The computer too often is programmed with only the notes, but not with the *style*—that part of the music which is indigenous to a culture or time. Without the proper style, music tends to sound "wooden" or "dead."

About the Author
Jef Raskin's credentials in music include his years as a professional musician and a music teacher. He is presently the manager of Advanced Systems at Apple Computer Co. His personal music and computer equipment includes a piano, a harpsichord, an organ, a PDP-11, and three Apple II computers.

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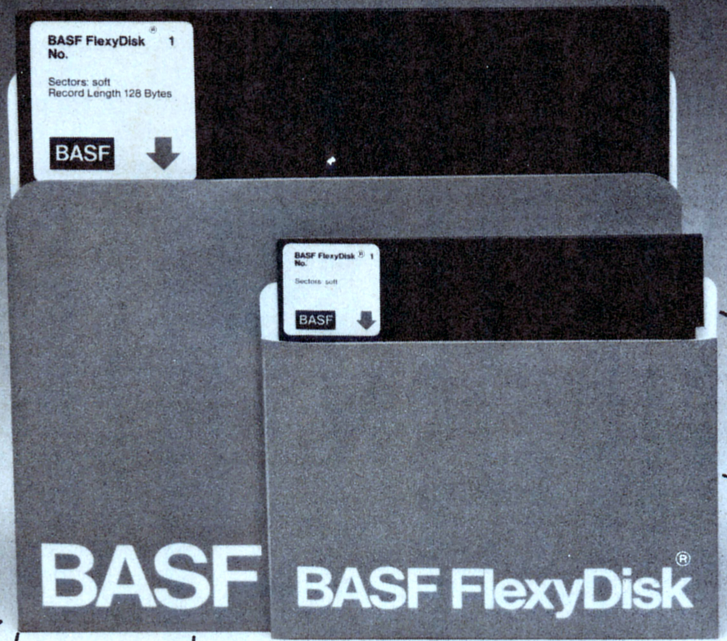

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Someone Tries to Sell the Author a "Notating Machine"

An entrepreneur tried to interest me in funding a device he was in the process of patenting. According to him, it would do the "simple" task of transcribing any rhythm tapped out on its surface into standard musical notation. It was to be the size of a hand-held calculator.

I asked him the questions that I have brought up in this discussion, and it soon became clear that he had not given the matter even as much thought as I have been giving the problem in this article. As an answer to the question of accelerando and ritardando, he suggested that the instructions would specify that the user must not slow down or speed up.

As happens too often in the world of computing, he was forced to lean toward a device that would—perhaps—write down the easy rhythms, leaving the difficult ones for the user to figure out. Most users, I suspect, would rather have a device to write down the difficult rhythms. The users can figure out the easy ones without mechanical aid.

Incidentally, one of the most difficult problems for a beginner to solve is determining on which beat of a measure a piece begins. Pieces very often begin in the middle of a measure. This is also a vexing problem for anyone who would program a computer to notate rhythms.

Placing any restrictions not found in the music itself on the user seems inherently wrong to me. The system must accommodate the person, not the other way around.

There are many other problems with rhythm—for example, *rubato*, where one part momentarily goes faster or slower than accompanying parts. Another class of problems are rhythmic complexities such as triplets, grace notes (so short that their time value is not notated), and other groups of notes that break the simpler rhythmic patterns.

A *triplet* is a melodic phrase consisting of three notes of equal length, three quarter notes, for instance. These three quarter notes are played in the same time interval that two quarter notes occupy in the normal rhythm of the piece. It is difficult to tell what has happened when a few triplets are introduced in a piece. When they first occur in a piece, you may ask yourself (if you are a trained musician), "Has the tempo suddenly changed, or have triplets been introduced?" The program will be hard put to guess at the difference.

Another problem occurs when very long notes occur in a piece which previously consisted only of relatively short notes. You must decide, for instance, whether to write them as tied shorter notes or as longer note forms. Of course, they might be written as the *same* note-length notations as the earlier, shorter notes, but with a tempo change!

All of this judgment of tempo must be done in the face of the first problem, that the note lengths and inception times are not coming in precisely, but with considerable variation. Often, the amount of this variation may mask tempo or rhythmic changes. Consider, too, that the people who need the Composer's Aid most are those who may be least proficient at performing upon conventional instruments. The designer probably has a more difficult task to make the Composer's Aid accurately portray the muddled attempts at rhythmic regularity of a beginner, than to make it follow the (probably) more precise playing of a master.

Before leaving the subject of rhythm, I shall take the liberty to give the following advice to all would-be designers of automatic music-transcribing systems. First, build one that has but one key or button, and get it to determine rhythms correctly. By "correctly" I mean without unreasonable limitations. It should be able to handle any rhythm found in a Mozart or a Beatles' melodic line. If you cannot master that, then you certainly cannot transcribe more complex music, which might have a solo melody as a part of a piece.

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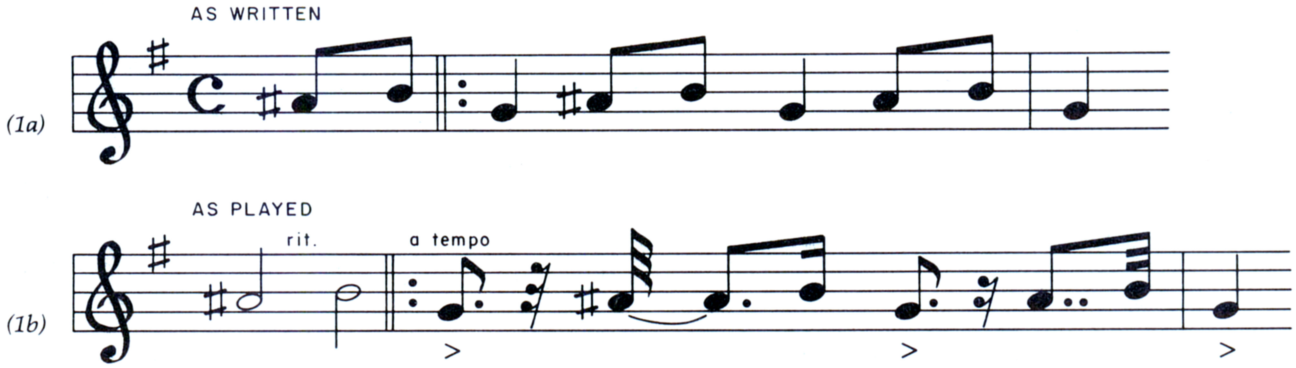

Figure 1: *The same passage as written (1a) and as performed (1b). Both examples here are from the "St Louis Blues."*

unexplored. Some of the algorithms that adaptively follow varying-rate Morse code may be useful. A number of moderately successful programs, all quite large and complex (using many techniques from artificial intelligence work, and *not* operating in real time), have been created. [*The October 1976 issue of BYTE contained several discussions of Morse-code decoding problems. . . .***RSS**]

If you first succeed with rhythm, *then* you might have a chance at the rest of the problem. At least a good portion of the problem of transcribing a musical performance into a standard score will have been solved.

More and Less

It is clear that a performance of a piece often contains *more* information than is given in the score: things happen in the performance that are not specified in the written music. Jazz, usually played from sketchy "charts," is an especially good example. The lilting "dotted" rhythms of jazz are notated as equal notes on the page. But everyone "knows" how it should sound. Look at the example from W C Handy's "St Louis Blues" in figure 1.

It is clear that the performance in figure 1b is quite different from the written notation in figure 1a, as it must be in order to sound right. The figure shows just one possible way of singing the opening measure of the chorus to the "St Louis Blues" (and it is not an especially extreme example).

It is rare, if not unheard of, that two live performances are the same. Some of the changes are minor, such as changing two eighths to a dotted eighth and a sixteenth. More surprising is the modification of the opening two eighth notes into half notes (with a ritard, no less). But that is the way it is done.

Strangely enough, the same convention about playing eighth notes with a certain uneven lilt occurs in much baroque music, in spite of the fact that the notes were written down as being of equal length. Many performances of Bach's music, for example, are marred by a "wooden" playing of such passages.

Many conductors and performers play baroque music exactly as it is notated. It sounds as if you tried playing jazz or rock exactly as written in songbooks and sheet music: the result is dull music. This may help to account for some of the comments about baroque music sounding like a melodic sewing machine—some performers play it as though their in-

INPUTS				
Musical Idea	Score	Keypresses	Sound	OUTPUTS
Inspiration	Plagiarization	Stimulation	Synthesized Music	Musical Idea
Composition	Arranging, Copying	Transcription	Taking Dictation	Score
Improvisation	Performance	Coupling	Playing By Ear	Keypresses
"Science Fiction"	Automation	"Sonification"	Transmission	Perceived Sound

Table 1: *Musical transformations, representing the various ways of obtaining musical results. The table is read by starting at the top at a given input and proceeding downward and to the right to read the output. The shaded example illustrates that the term* performance *describes the connection between a printed score and the production of keypresses. (For simplicity's sake, the table deals only with keyboard instruments.) Similarly, to go from a musical idea (ie: input) to a score (ie: output) requires "composition." The term* coupling *refers to the mechanical addition of extra voices to an organ keyboard so that the organist can play more than one pipe with a single keystroke.* Automation *refers to the procedure by which mechanical musical instruments (such as music boxes and player pianos) take a score in machine-readable form and generate perceived sound. For want of a better word,* sonification *is used to describe the production of perceived sound from pressing a key on a keyboard. The terms in the row called "musical idea" are meant to be taken tongue-in-cheek.*

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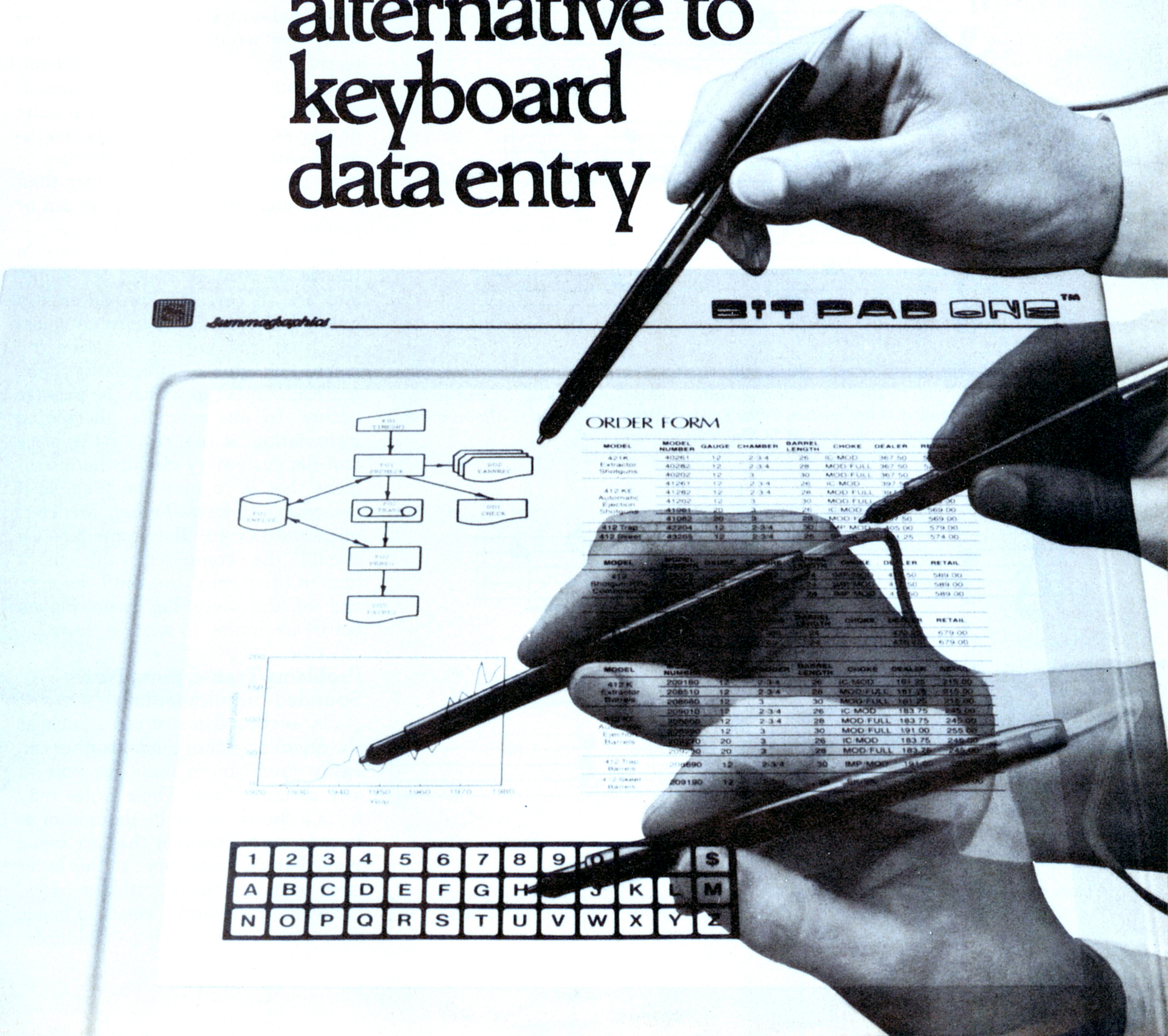

struments *were* sewing machines, without any regard for the original stylistic intent.

Problems Caused by Repeats and Larger Musical Structures

Here is another dilemma: how can a computer (or a human) tell if a section of a piece being performed has been repeated (perhaps with embellishments), or if it is a new section merely similar to the old one?

For example, in a Mozart rondo for the piano, almost all of the embellishments will be written out in full. In a Mozart sonata for the piano, there will usually be repeats marked and any variety will be at the performer's option. Does this mean that the computer must first be told the form of the piece before it can transcribe it? Knowing the form of a piece beforehand certainly aids a human transcriber.

Again, there is vague and general information that must somehow find its way into the program. As in having the computer play chess, methods have been found for translating an imprecise notion (eg: control the center of the board) into algorithms. Chess is a rich field, rife with human invention and complexity. Music is a more complex environment.

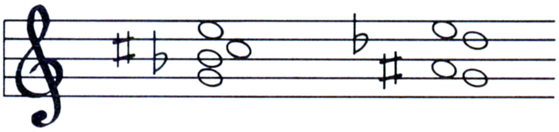

Figure 2: *Example of the equivalence of two musical notations. The chords notated here are played the same way on a keyboard instrument and sound the same, but they are written in different ways. This difference, however small, subtly influences the way many musicians interpret the chord.*

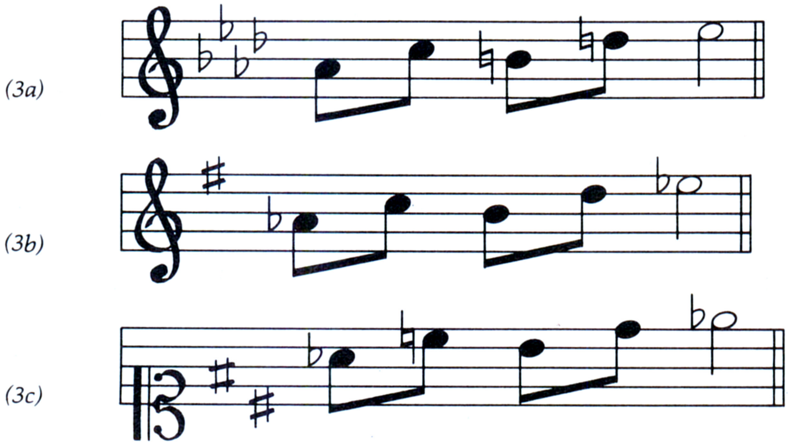

Figure 3: *Different notations for the same sounds. The three melodies here, when played, will sound exactly the same; the only difference is the choice of clef and accidentals. The first two melodies are written in the keys of A-flat Major and G Major in treble clef; the third melody is in the key of D Major in soprano clef.*

Problems With Notating Pitch

Having shown that there is information in a performance that is not to be found in the score (this is always the case), I would like to show that often there is information in the score that cannot be gleaned from the performance. The "spelling" of chords is one example. The two chords in figure 2 sound exactly the same on our equal-tempered organ. Nevertheless, they would be thought of differently by a musician playing them.

The notes of the two chords actually represent different pitches if sung or played on violins (or any instrument which allows the performer to vary pitch continuously rather than in discrete steps, as with an organ or piano).

The three sets of melodic notes in figures 3a thru 3c sound the same, and are all correctly but differently notated. Again, a human might guess which is the correct notation by means of global information, the musical context in which the passage occurs. In this example, the global information is the key of the piece and the customary clef of the instrument that is to play the tune. Is it reasonable to have the user predetermine the key for the computer? Or should the computer wait, as a human often must do, until the very end of the piece has been played before beginning to write it down?

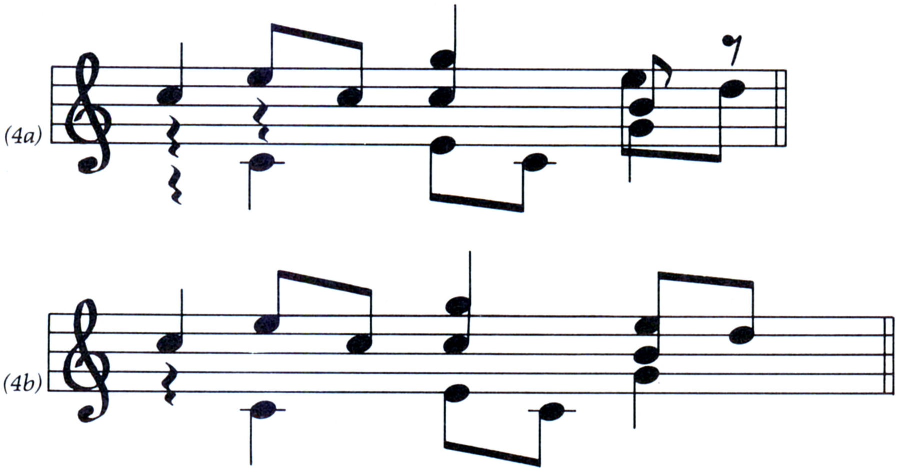

Figure 4: *A musical phrase played with two different voicings. These two phrases may sound the same, but the two correct, differing notations convey different meanings to a musician.*

Problems Transcribing Notes Sounded Simultaneously

On keyboard instruments such as the organ or piano, the performer can easily sound more than one note at any given instant. These notes may form a chord, or can be thought of as two or more melodies that are being played at the same time. In this latter case, each melody is called a *voice.* (This use of the word "voice" in music does not imply singing.) Multiple,

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simultaneous voices bring another host of difficulties to the attempt for accurate transcription.

It is nearly impossible for even an expert musician to determine unambiguously, from listening alone, which note should be allocated to which voice. I realize that this portion of the discussion is delving heavily into the terminology of music, but the intricate details of music are what make this problem so fascinating. The two segments of music in figures 4a and 4b sound the same, and are both notated correctly. Nevertheless, the differences are significant and useful to the musician performing the music.

This is not the place to go further into the musical significance of these notational differences. Enough examples of problems have been amassed to give you a starting place at which to begin to think about having a computer "listen" to and "understand" music.

Problems in Determining Pitch With a Computer

If things were not difficult enough given direct input from a keyboard, many people (eg: ethnomusicologists) would love to be able to play a recording into a computer and produce a written score. So would I. However, two new problems are introduced. Finding what pitch is being played is not easy. To be sure, a simple sine wave could be digitized by a frequency counter. Unfortunately, real musical sounds are far more complex, often having harmonics and overtones that make almost any frequency-determining method unsure. And what do you do when a note slides from one frequency to another (*portamento* in musical jargon)? Or when a chorus finishes singing a chorale a semitone lower then when they started—will the computer notate it as a sudden modulation in the middle?

Even determining how long a note lasts is difficult. Try playing a piano note; strike a key and hold it down. How long does it last? Just when does its gradual dying away cease? In a quiet room, with a good piano, it may take several minutes. You might as well ask where the rainbow changes colors. Musical sounds often do not have well-defined edges with respect to time or pitch.

Summary

The point has been made, and it is possible to show many more examples than have been shown here that you cannot go from a performance to a score, or vice versa, in any easy fashion while preserving the qualities that make the notation of music readable to most musicians and the properties of a performance that make it worthwhile listening material.

A score is a highly idiomatic rendering of a piece of music, and a piece of music is a unique instance of the composition that the composer had in mind when the score was written.

These facts assure that the building of a perfect music transcriber is literally impossible. Whether it is possible to make the Composer's Aid good enough for most practical purposes remains to be seen. If we put low enough limits on the idea of "good enough," I am sure that it can be done quite easily. If it is to satisfy me (and musicians of like mind), it will probably not be easy at all.

A final suggestion: if you want to tackle any project of this sort, make sure that you know music well. Also make sure that you know your computing well or forge a partnership that can provide the needed experience. I have met many people who do not know the first thing about music trying to achieve difficult goals combining computers and music. I have also met musicians who imagined that they could get the computer to do some task that they found very easy—only to discover that they did not understand the difficulty of what they themselves could easily do.

The greatest benefit the computer confers upon mankind is that it forces us to truly understand what we are doing, for it is only through such understanding that we can instruct a computer. ■

Acknowledgments

I would like to thank the many people who have made useful suggestions about this article, and I would like to specially mention Doug Wyatt of the Xerox Palo Alto Research Center for many useful discussions about the nature of music, Brian Howard of Apple Computer Co for his excellent editing and criticisms, and both of them for the many hours of rehearsal, performance, and programming that they have shared with me.

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Comparing Floppy-Disk Drives by Software Simulation

Dennis Nendza
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Large companies learned long ago that preliminary performance specifications of systems can be predicted reasonably well by computer simulation. The National Aeronautics and Space Administration (NASA) saved much money and effort by simulating numerous systems that have been developed for the space program. In a somewhat smaller way, microcomputers can be used to simulate a variety of operational systems. Complex equations and analysis are not always required.

Here I shall present a practical simulation. I have chosen a topic of interest to myself and many small-computer enthusiasts: a comparison of the operating speeds of floppy-disk drives. This article will explain basic mechanical drive movements and illustrate the transformation of these physical events into the algorithmic steps of a computer program. Estimating one drive's performance in relation to others is the goal.

To do such a comparison, we need some knowledge of the operational parameters of floppy-disk drives. These parameters are the lengths of time required for a drive to perform a given function. All drives have at least these four parameters:

- head load
- seek
- rotational latency
- data-transfer rate

I shall look at each function in detail.

Head-Loading Motion

Before any data can be located or transferred on some drives, the data-transfer head must be *loaded*; firm contact between the head and the disk surface must be assured. To accomplish this, a pressure pad is placed against the disk on the side opposite the head. This pressure pad movement is referred to as *loading the head*. The length of time required to move the pad into place and insure that all mechanical bouncing has stopped is termed *head-load time*. Look at figure 1 to see a diagram of the head-load mechanism.

Track-Seeking Motion

Once the head is loaded, it may be necessary to move the head to a position over another data track on the disk. In most drives, the track-to-track movement, or *seeking*, is accomplished by a *stepper motor*. This motor rotates in steps of fixed, discrete increments; a specific interval of time is required for each incremental movement. Thus, to move the head across X tracks takes an amount of time equal to X intervals. Once we know the time interval required to perform a movement and the number of tracks to move across, we can predict how much time it will take the head to reach the desired track.

All stepper motors exhibit some vibration at the end of the last step in a given movement. There may be a settling time required before a read or write operation can begin.

Another type of motor is used in floppy-disk drives such as the PerSci Model 277. It is called a *linear motor* since it produces linear motion directly. The method is also called "voice-coil" positioning, due to the similarity to the action of a loudspeaker mechanism. Figure 2 depicts the stepper- and linear-motor positioning systems in simplified form.

The amount of time required per track for the linear motor to perform a seek operation varies according to the total number of tracks to be skipped. Unless the manufacturer supplies data describing the seek-time

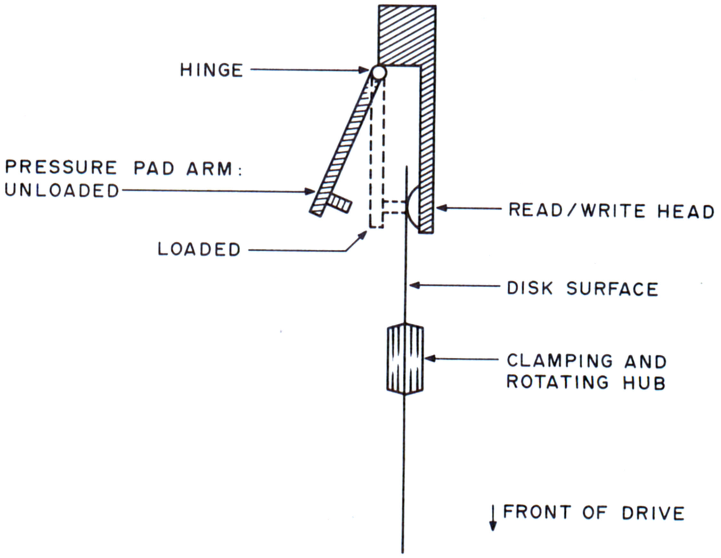

Figure 1: *Diagram showing a side view of the floppy disk loaded in the drive. When loaded, the read/write head is pressed against the surface of the disk by the pressure pad.*

About the Author

Dennis Nendza is 32 years old and is currently working as a computer systems consultant, after previous experience as a systems programmer, analyst, and data processing manager. He wrote his first computer program while in high school, using the ALGOL language.

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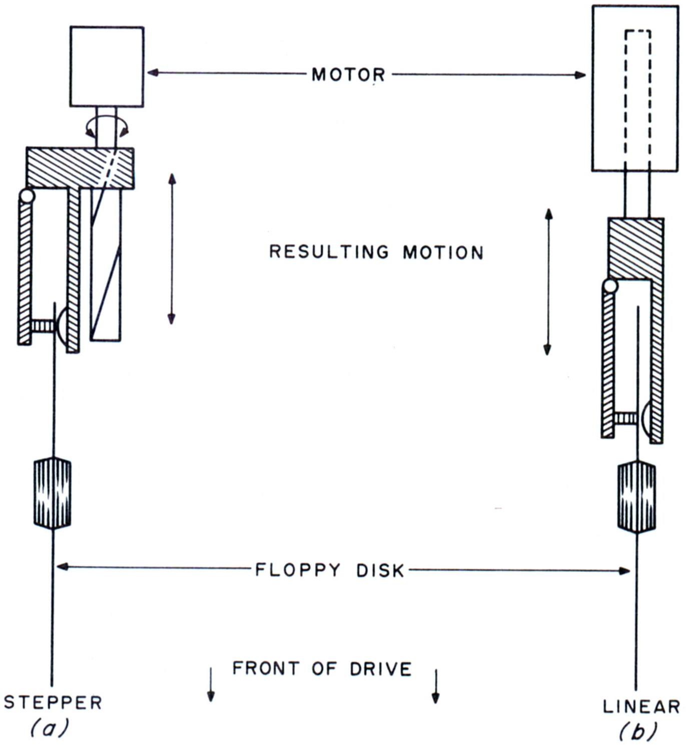

Figure 2: *Two methods of moving the read/write head from track to track across the disk. A stepper motor is shown as (a); a linear or "voice-coil" motor is shown as (b). The rotary motion of the stepper motor must be converted into linear motion by a gear arrangement.*

function, it must be derived from empirical measurements. This derivation, however, is not within the scope of this article.

Rotational Latency

Reading and writing operations are equivalent functions with respect to the actual time required for completion. With that in mind, the discussion will proceed as if a read operation is being executed. Assuming that the head is now loaded and positioned over the proper track, it remains for us to examine how long a delay may be expected in waiting for the desired record to spin past the head.

A look at figure 3 shows how most soft-sectored disk formats appear. Actually, the soft-sectored format contains 128 bytes of user data; the other data locations are used as address marks and gaps between certain fields. To determine the extent of the delay that must be endured before the desired sector is available, I will consider two cases.

The first case occurs when we begin a read operation and find the correct sector just about to pass by the head. In this event, there is no wait or *latency*, as it is called, before starting the transfer of data. The second case shows that the beginning of the desired sector just went by an instant before the read operation was started. We must now wait for one full rotation of the disk, or the *maximum rotational latency*, for the record to appear at the head again. These two extreme cases show that there are well-defined minimum and maximum rotational latencies. Of course, most delays will be at some random point within this range for actual read operations. The absolute delay for a single read operation is not predictable, but the average for a group of read operations is predictable within limits.

Data-Transfer Time

Finally, there is the most obvious function of the disk drive, data transfer. Data-transfer time is dependent on three basic parameters: disk rotational speed, data density, and format. The faster the disk surface spins past the head, the faster the

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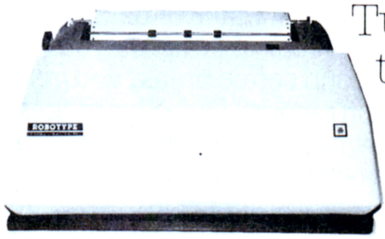

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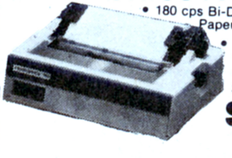

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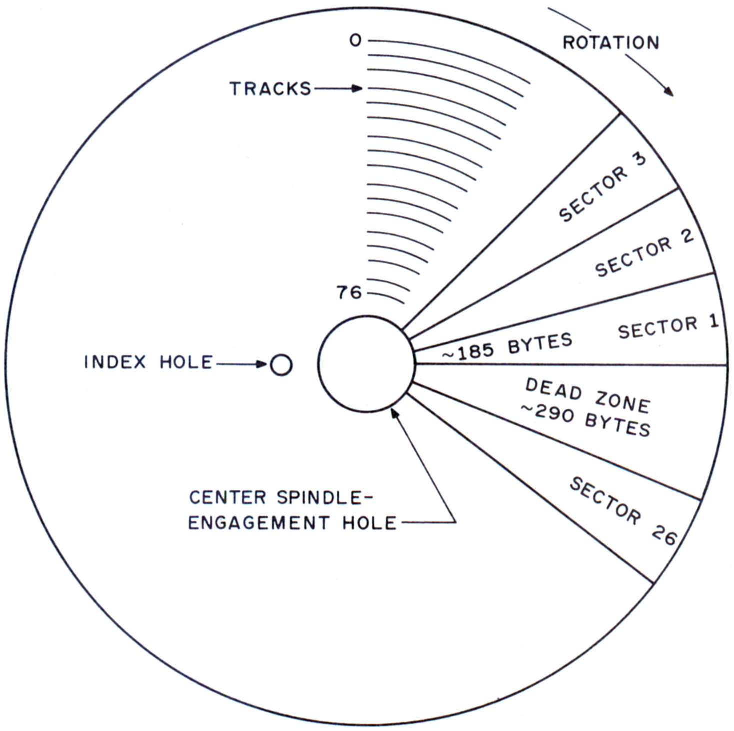

Figure 3: *Format of data storage on a soft-sectored, 8-inch floppy disk, viewed from the side that faces the pressure pad.*

head can read the data. (Large 8-inch disks spin faster than the smaller 5-inch disks.) The higher the density, the more data can be transferred in a given interval of time. Format differences can account for different effective transfer rates on large records, but will not be dealt with in this simulation. I will deal primarily with the standard IBM 3740 soft-sectored, 8-inch floppy-disk format.

Building the Simulation

We now have an understanding of what happens when a function of the floppy-disk drive is requested. We can now construct a program framework that will use this information. To read or write a record, we must pass through four distinct states: head-loading, track-seeking, rotational-latency waiting, and data-transferring. To compute the actual time required to pass through these states, we must get some information from the manufacturer's specifications for a given drive. Typically, the manufacturer will list the time for head load, track step, average latency, and sector transfer in milliseconds.

Head-load time calculation is easy. Each time that the head is loaded, a value corresponding to the head-load time is added to a total-time accumulator. As a matter of practice, most drives and control software leave the head loaded for a fixed-time interval following a disk operation. This reduces head-loading delays and acoustic noise, but it also increases disk surface wear slightly. For most programs (such as assemblers) that engage in almost continuous disk activity, the head will probably go through the load cycle only once during an execution of the program.

Computation of track-step time is not difficult in most cases. We merely figure the number of steps we must make from the current track to the desired track, and multiply that value by the specified track-step time. Do not forget to add the *settling* time, if the manufacturer gives it. (Remember that the settling time indicates the time taken by the head to stop vibrating from its track seeking and to start reading.)

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motors, the seek time is the absolute value of the distance from the current track to the desired track multiplied by the track-step time, all added to the settling time, or:

$$T_{seek} = ABS(P_{current} - P_{desired}) \times T_{step} + T_{settling}$$

where T is used for values of time, and P shows the position of the head in relation to data tracks on the disk.

But what should be done when the disk drive uses the linear-type motors to move the head from track to track? The specification sheets for the PerSci unit give only a single-track seek time of 10 ms. Is that the same as the stepper-motor drive timing? No—this timing is for a single-track step, and there is no settling time to be added. In fact, if the two-track seek time is measured, it is one and one-half times the single-track seek time. If a ten-track seek is measured, we find that it takes only three times as long as moving the head a distance of one track.

Well then, what can be done about this device? For this simulation, my plan of attack was direct. I merely measured the time that it took for all possible seek distances (seventy-six values) and then computed an approximating function by using a least-squares polynomial curve-fit calculation. The concepts behind this computation are not simple. Fortunately, the routine is adaptable from a book that addresses such problems, *Data Reduction and Error Analysis for the Physical Sciences* by Philip R Bevington (McGraw-Hill Book Company Inc, 1969).

When the seek time for the PerSci drive is needed in my simulation, the number of tracks the head crosses is evaluated and is given as an argument to the empirically derived seek-time function. The result of the function evaluation is the number of milliseconds required to complete the seek. Thus, the PerSci drive becomes a special case in the simulation, but handling it is not so awkward.

To compute the rotational latency, one of two possible techniques is employed. For any large number of discrete read operations, the actual, average rotational latency experienced will approach one-half of the maximum latency. This value can be used for each read operation as a typical latency. I prefer to calculate a random latency for each read operation. Approximately the same results will appear as in the first method for a large sampling of read operations. You will notice that the results from using random latency values are not likely to be the same each time the program is executed. This is due to the accumulation of random variability, which is an effect you would see if the simulation were carried out on real hardware as well as in a program. The function for randomly determining a latency time is simply: the value of the maximum latency multiplied by a random number between 0 and 1.

The final item which must be dealt with is the actual time it takes the drive to transfer the data to (or from) the disk. The time to transfer 128 bytes of data has been chosen for this simulation. The time values for each drive in this simulation were calculated based on the rotational speed and data density. Record overhead bytes and interrecord gaps were not considered. In the simulation program, the computed values are reflected in the appropriate field in DATA statements that describe the characteristics of each drive. Transfer time for *n* bytes is calculated by multiplying *n* by 8, and then dividing by the *transfer rate*, in bits per second.

About the Simulation Program

Now that we understand the basic drive mechanics, there should be no difficulty in comprehending how the simulation works. The program performs two simulations for each disk drive under consideration.

The first simulation is a set of 500 sequential-read operations, as you would find in a sequential file-copy operation. The second simulation involves a random reading of 500 records, as you might encounter in a program that reorganizes an indexed file according to an unordered secondary key field.

These two modes of access will exhibit the characteristics of general interest concerning floppy-disk drive performance. Briefly, the program steps through the DATA statements that supply the drive name and parameters for that drive. Both simulations are run for a given drive,

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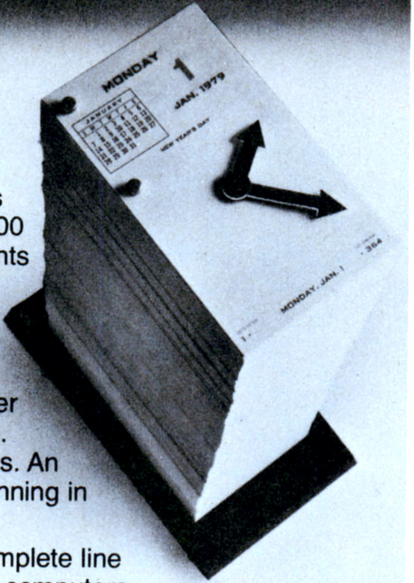

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and the results are printed. Look at the program shown in listing 1 to see the simple logic and computations.

Results and Notes

If this simulation were run using a true random-number generator, you would find that the resulting timings will vary on each run. As noted earlier, this is random variation that is to be expected. Do not expect to see exactly the same results as printed here; the values *will* be within a few percent on all runs.

Referring to the simulation output shown in listing 2, observe that, on sequential-read operations, the transfer times for the 5-inch floppy-disk drives are about 25% slower than the times for the standard size (ie: 8-inch) drives. Allowing for random variation, this is very close to the 20% speed difference that might be predicted based on the different rotational rates of the two sizes of floppy disks. The 8-inch disk drives also outperform the 5-inch drives during random-access operations. Most, but not all, of the smaller drives are slower in seeking from track to track, and this really shows during random access.

The fastest-seeking drive of the group, the PerSci Model 277, does not get a chance to show off while reading sequentially, but its capability becomes apparent during random-access operation. This device really moves the head fast! The second and third places go to the Memorex Models 552 and 550 respectively; these use fast stepper-motor drives.

Now that you have read this far, I can reveal some bad news concerning this simulation. The timings obtained are not likely to be a true indication of how long it would take to actually perform these operations on a running computer system. Accomplishing so realistic a simulation involves additional simulation of the interface

Listing 1: *Program to simulate mechanical characteristics of various 8-inch and 5-inch floppy-disk drives, written in BASIC-E and running under the CP/M operating system. One step is the simulation of 500 sequential-read operations; the other is the simulation of 500 random-access read operations. Due to the use of random numbers, some variation of results is expected between different executions of this program.*

```
REM   PROGRAM TO COMPARE ACCESS TIMES OF VARIOUS FLOPPY-DISK DRIVES FOR
REM   SIMULATED SEQUENTIAL AND RANDOM READING.
REM
REM   THE FIRST TEST IS FOR 500 SEQUENTIAL READS, 128 BYTES PER READ.
REM   STARTING TRACK IS 0. THE HEAD IS LOADED AND REMAINS LOADED.
REM   WHERE A DRIVE HAS SECTORS GREATER THAN 128 BYTES, THE SECTOR TRANSFER
REM   RATE HAS BEEN ADJUSTED IN THE DATA FOR THAT DRIVE.
REM
REM   ALL TIMES ARE IN MILLISECONDS.
REM
READ DRIVES                               REM GET NUMBER OF DRIVES TO SIMULATE
INPUT "ENTER ANYTHING TO SEED THE RANDOM-NUMBER GENERATOR";A$
PRINT :  PRINT : PRINT                    REM UPSPACE A FEW LINES
PRINT TAB(30); "FOR 500 READ OPERATIONS"
PRINT TAB(25); "DRIVE SPEED COMPARISON SIMULATION"
PRINT TAB(30); "ALL TIMES IN MILLISECONDS"
PRINT
PRINT "DRIVE NAME"; TAB(25);"SEQUENTIAL";TAB(40);"RANDOM"
PRINT TAB(25);"-------------+-------"
PRINT
RANDOMIZE                                 REM SHAKE UP RANDOM-NUMBER GENERATOR
FOR D=1 TO DRIVES
    READ DNAME$,TTRK,TSETL,HLOAD,LATENCY,SECREAD,NSECS,NTRKS
    CURTRACK=0                            REM STARTING TRACK
    TOTALTIME=0                           REM SET TIME ACCUMULATOR TO 0
    REM LOAD THE HEAD ONCE FOR THIS SEQUENTIAL TEST
    GOSUB 1000                            REM GO ACCUMULATE HEAD-LOAD TIME
  FOR I=1 TO 500                          REM 500 SEQUENTIAL READS LOOP
    GOSUB 2000                            REM STEP TO NEXT TRACK IF NEEDED. ACCUMULATE TIME
    GOSUB 3000                            REM READ NEXT RECORD. ACCUMULATE TIME
  NEXT I
  REM  PRINT RESULTS FOR TEST 1
  PRINT DNAME$;TAB(28);INT(TOTALTIME*10)/10;TAB(40);
  REM  NOW FOR 500 RANDOM READS IN A FILE 35 TRACKS LONG
  TOTALTIME=0                             REM SET TIME ACCUMULATOR TO 0
  LOWTRACK=0                              REM LOWER FILE TRACK LIMIT
  HIGHTRACK=34                            REM UPPER FILE TRACK LIMIT
  CURTRK=0                                REM START AT TRACK 0
  FOR I=1 TO 500                          REM 500 RANDOM READS LOOP
    NEXTRK=LOWTRACK+INT(RND*35)                       REM NEXT RANDOM TRACK
    TRACKSTOMOVE=ABS(CURTRK-NEXTRK)                   REM NUMBER OF TRACKS TO TRAVERSE
    GOSUB 2500                            REM COMPUTE TIME TO DO SEEK. ACCUMULATE IT
    GOSUB 3000                            REM COMPUTE RECORD READ TIME. ACCUMULATE IT
    CURTRK=NEXTRK                         REM NEXT TRACK HAS BECOME THE CURRENT TRACK
  NEXT I
  PRINT INT(TOTALTIME*10)/10              REM PRINT RANDOM READ RESULTS
NEXT D
STOP
REM  SUBROUTINES FOLLOW
1000 REM ACCUMULATE HEAD-LOAD TIME
```

Listing 1 continued on page 140

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These programs, unless otherwise indicated, are for the 16k, Level II TRS-80.

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Also available are "Datestones of Ryn," the microquest which is the introduction to the Dunjonquest series and "Morloc's Tower," the deadliest of the series. $14.95 on tape, $19.95 on disk, each.

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by Cottage Software

This is the ultimate editing tool for BASIC program lines. There are five commands which allow easier reading of BASIC programs and more efficient execution by the computer.

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So if your programs need more memory, or you need more time, order your 'packer'! 16k, 32k and 48k versions supplied on two cassettes for $29.95.

SYSTEM SAVERS

by Tom Stibolt from Acorn

If you ever use the SYSTEM command, you should buy this two program package. These programs allow you to save any system format tape on tape or disk, plus offer several features for machine language programmers. Many two part, protected system tapes like Sargon II are not system format.

With FLEXL, which is one of the two programs, you can make back-up copies of any system format tape. Most often a cassette that you make will load easier than an original. Plus you can find the filename on any system tape because it is displayed on the screen. And at any time you can stop the reading of the tape by pressing <BREAK>.

For any machine language programmer, FLEXL offers the advantage of producing more efficient tapes than the assembler. Also, it is written to interface directly with monitor programs. And you can merge machine language tapes into one file.

Disk drive owners can use TDISK to save any system format tape onto disk. Adventure, Airaid, Ting-Tong, Editor / Assembler and other programs cannot normally be loaded to disk using TRSDOS. Now, TDISK allows you to save these programs onto disk. After DOS READY you will be able to simply type the filename and be up and running. It even loads non-contiguous tapes. TDISK will greatly increase the benefit of owning a disk drive.

And as a FREE BONUS, Acorn provides instructions on how to load MicroChess 1.5 onto disk.

Complete your system with the routines not found in either Level II or DOS for only $14.95. Order your System Savers, today!

TRS-80 DISK & OTHER MYSTERIES

by H.C. Pennington

We don't usually list books, but this one is so unique that we thought you would want to know about it. There are over 100 pages about how DOS works, how a disk is organized, and how to recover from errors. This is THE technical backup for NEWDOS+ with great illustrations. $22.50.

DISK*MOD

by Roy Soltoff from Misosys

This machine language program modifies your copy of the Radio Shack Editor/Assembler for use with your minidisk and any disk operating system. You can save and load both text source and assembled object files. Unlike the NEWDOS+ version you can read the directory and the allocation of granules while in the EDTASM. You can also kill files. It is a complete disk modification for one or more drives.

Other capabilities are also added which are not found on NEWDOS+. The block move command relocates a section of text to any other area. The global change command permits, for example, changing a label throughout the text. The pagination feature provides hardcopy on 8 1/2 by 11 pages on either single sheets or continous paper. In addition, high memory can be reserved, like in BASIC, for machine language routines like printer drivers. You can also display the amount of memory remaining.

The <CLEAR> key is functional, the symbol table is sorted alphanumerically and output 5-across, the scroll up/down allows 15 lines on the screen, and the 'DEFM' assembly is improved. Lower case input is now permitted and you can branch to any address. Plus, it also corrects the errors in the Radio Shack tape version. $19.95

Also available for $239.95 for the TRS-80 Model II is a similar Editor Assembler from Galactic Software. Write for a complete list of Model II software.

DISASSEMBLER

by Roy Soltoff from Misosys & Acorn

This two-pass Z-80 disassembler produces symbolic labels with output to either the video monitor, printer or tape. Radio Shack's Editor / Assembler can load the tapes. If you own the Editor/Assembler, complete the package with this program. Program on tape for two different memory locations.

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Listing 1 continued:

```
  TOTALTIME=TOTALTIME+HLOAD
  RETURN
2000 REM COMPUTE SEQUENTIAL TRACK READ-SEEK TIME
  IF I/NSECS NE INT(I/NSECS) THEN RETURN        REM NO TRACK ADVANCE
2500 IF TTRK=0 THEN 2800                         REM USE SPECIAL PERSCI FUNCTION
  SEEKTIME=TRACKSTOMOVE*TTRK+TSETL              REM COMPUTED SEEK TIME
2600 TOTALTIME=TOTALTIME+SEEKTIME
  RETURN
2800 REM PERSCI-277 DERIVED SEEK TIME FUNCTION
  IF TRACKSTOMOVE=0 THEN :                      REM NO MOVEMENT REQUIRED
    SEEKTIME=0:                                 REM THEREFORE SEEKTIME IS ZERO
    RETURN
  X=TRACKSTOMOVE
  SEEKTIME=10.89605+2.178647*X-4.846975E-2*X*X+7.936448E-4*X*X*X-4.406022E-6*X*X*X*X
  GOTO 2600
3000 REM COMPUTE RECORD READTIME INCLUDING ROTATIONAL LATENCY
  RNDLATENCY=INT(RND*LATENCY)                   REM RANDOM ROTATIONAL LATENCY
  TOTALTIME=TOTALTIME+RNDLATENCY+SECREAD    REM ACCUMULATE READ TIME
  RETURN
REM   FIELD ORDER IN DATA STATEMENTS
REM   DRIVE NAME, TRACK-TO-TRACK TIME, SETTLING TIME, HEAD-LOAD TIME,
REM   MAX LATENCY, TRANSFER TIME, SECTORS PER TRACK, TRACKS PER DISK
DATA 12                                 REM NUMBER OF DRIVES TO SIMULATE
DATA "PERSCI 277",0,0,40,166.7,4.096,26,77
DATA "REMEX RFD 1000A/B",6,24,50,166.7,4.096,26,77
DATA "SHUGART SA800",8,8,35,166.7,4.096,26,77
DATA "SHUGART SA400 MINI",40,10,75,200,8.192,18,35
DATA "SHUGART SA450 MINI",25,15,50,200,4.096,18,35
DATA "PERTEC FD200 MINI",25,10,35,200,8.192,16,35
DATA "ICOM FD3800 DUAL-DENSITY",10,0,40,166.7,2.048,26,77
DATA "ICOM MICROFLOPPY",40,10,75,200,8.192,16,35
DATA "MEMOREX 550",6,10,35,166.7,26,77
DATA "MEMOREX 552",3,15,35,166.7,26,77
DATA "MICRO PERIPHERALS B51 MICROFLOPPY",5,15,35,200,8.192,16,40
DATA "ALTAIR 88-DCDD",10,10,45,166.7,4.096,32,77
END
```

and software delay characteristics. However, the relative standing of the drives is unlikely to change if these factors are included.

The important elements to consider for additional simulation are: the record formats on the disk, the interface and controller characteristics, processor speed, and the algorithm of the program performing the access.

As an example of the discrepancy between the simulation and the speed of the total system, I offer the following. My system uses a Z80 microprocessor running at a 2 MHz clock rate, and contains 24 K bytes of zero-wait-state memory. The drive controller, designed by George Morrow, connects to a PerSci Model 277 with the fast-seek option. The operating system is CP/M. The time to read 500 records sequentially using BASIC-E is 109 seconds; to read 500 records randomly takes 525 seconds. Compare these times with those in the results of the simulation for the PerSci drive. Beware of making system estimates based only on a part of the total operation. Does anyone want to write an article that describes operating-system timing simulation?

Listing 2: *Output of simulation results produced by the program of listing 1.*

```
                    FOR 500 READ OPERATIONS
                DRIVE SPEED COMPARISON SIMULATION
                    ALL TIMES IN MILLISECONDS

DRIVE NAME                              SEQUENTIAL          RANDOM
                                     --------------+-------


PERSCI 277                                43107.6           57912.2
REMEX RFD1000A/B                          43650.1           92281.9
SHUGART SA800                             44163.1           94881.9
SHUGART SA400 MINI                        53547.8          288397.1
SHUGART SA450 MINI                        55153.2          198631.3
PERTEC FD200 MINI                         52804.8          201703.6
ICOM FD3800 DUAL-DENSITY                  43110.0          101456.6
ICOM MICROFLOPPY                          55698.8          293376.0
MEMOREX 550                               44821.1           77892.1
MEMOREX 552                               44000.1           66670.3
MICRO PERIPHERALS B51 MICROFLOPPY         55287.8           89390.2
ALTAIR 88-DCDD                            42634.1          108670.8
```

Two for One

There are two basic lessons to be learned from this exercise. The first one concerns an elementary introduction to the motions that occur in floppy-disk drives and affect their speed of operation. The second lesson concerns derivation of mathematical functions that describe these mechanical motions; it also concerns putting the functions into a program for the purpose of obtaining an estimate of performance. Performance, for the purpose of this article, considers only the relative speed of operation of the various drives. In making a decision to select a particular floppy-disk drive, you must understand that overall performance, not just speed of operation, should be examined. ■

IDS Announces
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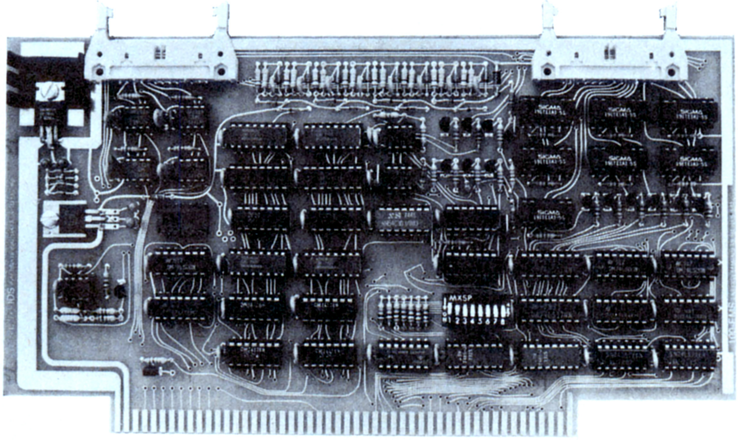
The 100-EMM Energy Management Module provides temperature measurement at four separate locations indoors or out; monitors eight (8) doors, windows, or fire sensors; controls six external devices via relay or optoisolator; and provides an intrusion alarm with battery backup (alarm operates even during primary power outages). Put the 100-EMM to use in your home or business and claim a 30% tax credit for the cost of your S-100 computer system including the 100-EMM. (Purchasing the 100-EMM can actually save you several times its cost in tax credits. Full instructions for filing are included in the 100-EMM manual.)



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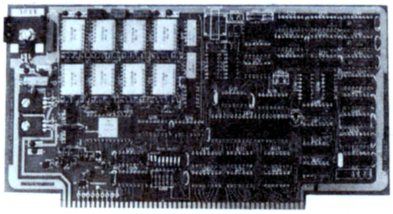

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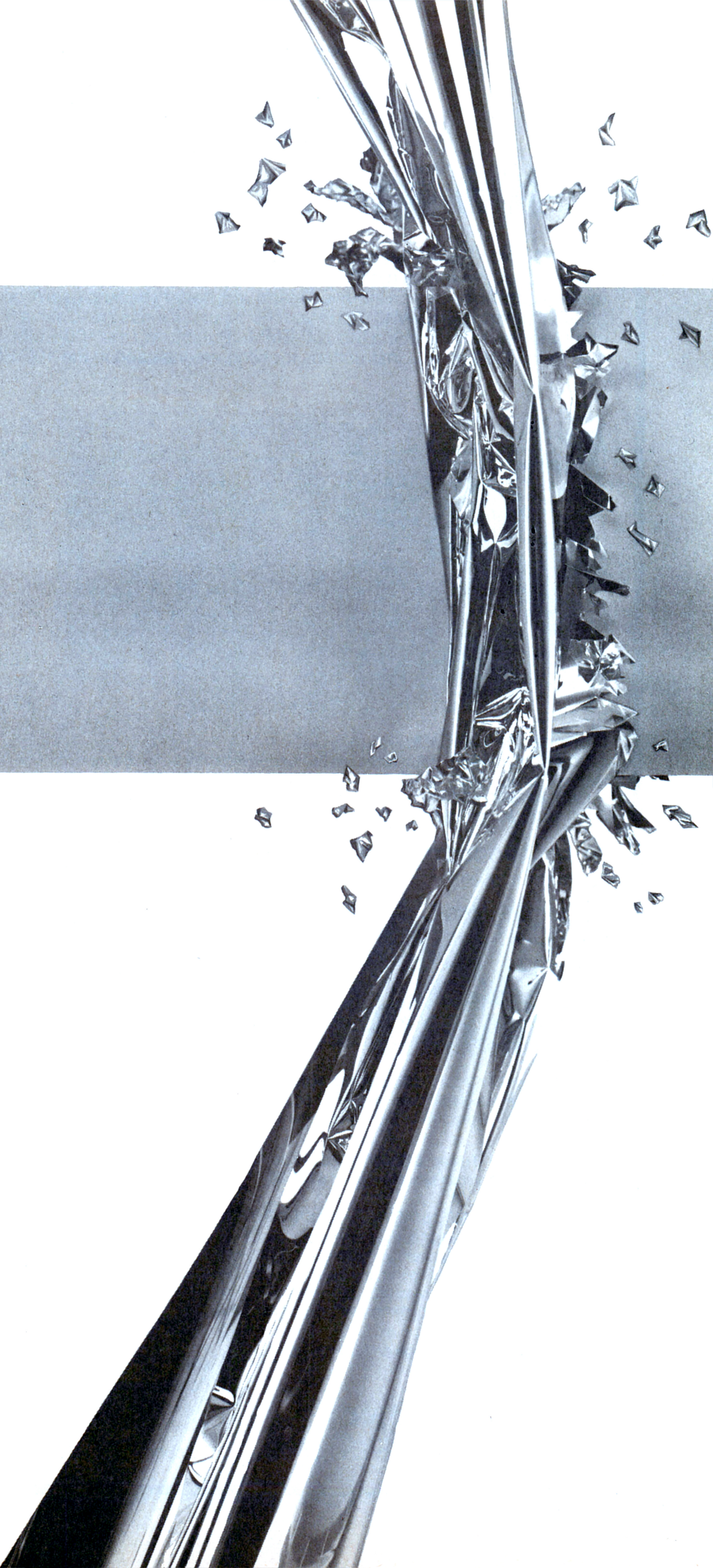

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ALTOS BREAKS THE MICRO BARRIER.

Yesterday, microcomputer meant micro performance. Once you outgrew it, you had to step up to a mini. Which meant a big step up in price.

Today, there's the new Altos ACS8000-6 single-board microcomputer system.

It's the first system for the OEM, small businessman and personal user, that offers minicomputer performance and minicomputer storage capacities—at a microcomputer price.

MULTI-USER, WINCHESTER STORAGE, FLOPPY BACK UP: $14,260.

The new Altos ACS8000-6 is a highly advanced Z80* based microcomputer system with high-speed RAM, floppy disk and Winchester hard-disk controllers, DMA, six serial and two parallel I/O ports and the AMD 9511 floating point processor all on a single board. A typical four-user system configuration with two megabytes of Shugart floppy and 29.0 megabytes of Shugart Winchester storage, including CPU and 208K bytes of RAM, costs only $14,260—compared to $30,000 or more for a similar minicomputer system. And that adds up to mini performance at less than half the cost!

MULTI-USER EXECUTIVE SUPPORTS FOUR INDEPENDENT USERS RUNNING CP/M COMPATIBLE PROGRAMS.**

This revolutionary new microcomputer system features the MP/M** Multi-User Executive software program that's unique in two ways. It includes a multi-user CP/M capability and the ability to handle Winchester-type hard disks. The advanced Z80 operating program supports four independent CP/M compatible programs in any of six popular languages: BASIC, FORTRAN, COBOL, PASCAL, APL, C, and a large assortment of additional business application packages. MP/M is compatible with both the 1.4 and 2.0 versions of Digital Research's CP/M, which means programs based on either version can run under MP/M without modification.

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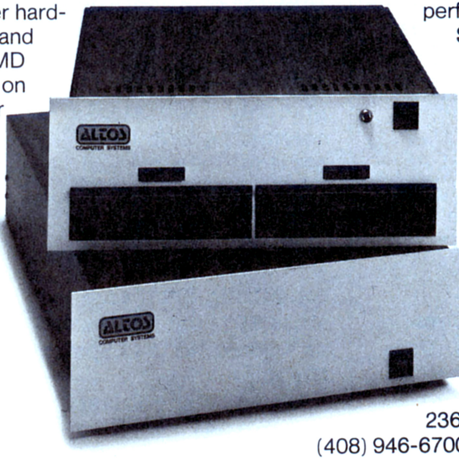

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ALTOS
COMPUTER SYSTEMS

BYTELINES

NEWS AND SPECULATION ABOUT PERSONAL COMPUTING

Conducted by Sol Libes

What To Look For At NCC: The computer show of the year is the National Computer Conference (NCC), which will be held this month (May 19 thru 22) at the Anaheim Convention Center in Anaheim, California. In 1979, 60,000 people attended the NCC. Many new products are introduced each year at NCC. The 1980 show will see many more Japanese manufacturers displaying, among other things, 8-inch Winchester disk drives and microcomputer systems. Furthermore, look for several manufacturers from the United States to show complete microcomputer systems that use the Zilog Z8000 and Motorola 68000 16-bit microprocessors. Last year's show saw the introduction of 8086-based microcomputers. Also, look for disk-operating-system-based languages and applications packages for these new 16-bit microcomputer systems. Several multiprocessing and multiuser microcomputer systems will also be shown.

John Mauchly, Computer Pioneer, Dies: Dr John W Mauchly, co-inventor of the digital computer, died on January 8, 1980 at the age of 72. Together with his colleague Dr J Presper Eckert, Dr Mauchly conceived, designed, and built ENIAC, the first electronic digital computer. It was built at the University of Pennsylvania and became operational in 1944. ENIAC contained thousands of vacuum tubes, filled 150,000 square feet of space, and weighed 30 tons. It was used for ten years.

Mauchly and Eckert later formed the Electronic Control Company (later called the Eckert-Mauchly Computer Corporation) to manufacture BINAC (Binary Automatic Computer), which became the prototype for the UNIVAC I (Universal Automatic Computer). The UNIVAC I was the first commercial computer; it was installed at the United States Census Bureau in 1951.

When the company was purchased by Remington-Rand in 1950, Dr Mauchly continued with the Univac Division as Director of Applications and worked on weather-forecasting projects. In 1959 he left to form Mauchly Associates, a consulting firm that developed the critical-path method for construction.

In 1967 he founded Dynatrend, a computer consulting firm, and since 1973 he had served as a consultant to Sperry Univac.

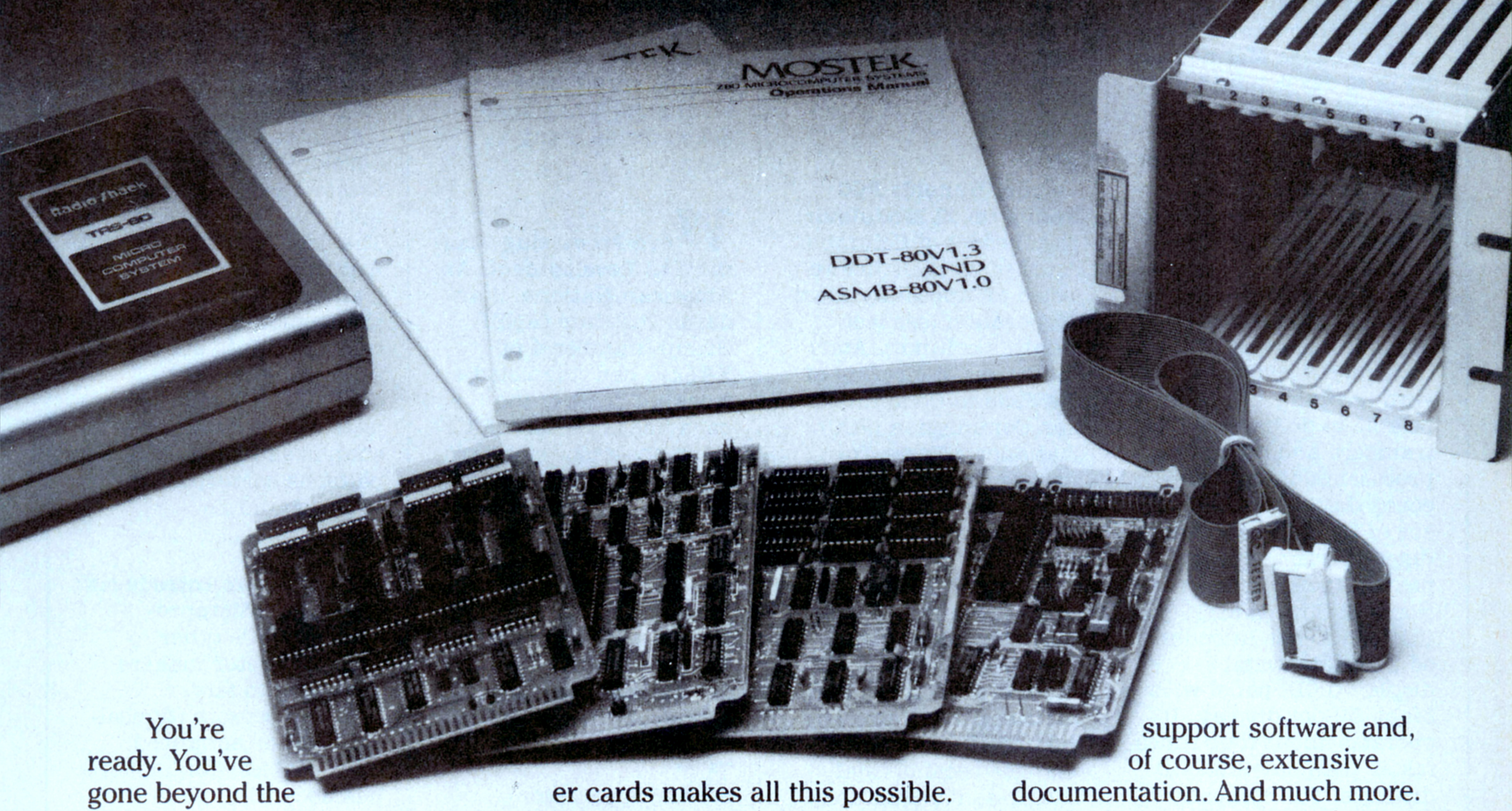
Mauchly and Eckert met in 1941 at the University of Pennsylvania's Moore School of Electrical Engineering, where both were instructors. They first proposed the building of the digital computer to the US Army in 1942 for calculating trajectory tables. ENIAC contained ten accumulators, had internal memory, used subroutines, and was all-electronic, while prior machines were electromechanical and very limited in power. Some parts of ENIAC can be seen at the Smithsonian Institution in Washington, DC.

At the time of his death Dr Mauchly was believed to be working on a word-processor project using a Radio Shack computer. He was an active proponent of personal computing, and he will be missed by many.

News Bits: Friends Amis has developed an interface for the Craig M-100 hand-held language translator that allows the user to add read-only memories containing data bases such as wine lists, Olympic scores, history, or metric conversion.... Panasonic will introduce a hand-held computer to sell for about $180 in late 1980. The RLT500 Electronic Data Center can be connected to a television set for display, to an acoustic modem for communication, to a printer for hard copy, or to a speech synthesizer for audible output. Quasar will bring out the HC2000RA Information Processor for $150, which should work with the accessories for the Panasonic machine.... Amateur robot builders have a new source for parts: Vedos Ltd, Suite 1113, 19 W 34th St, New York NY 10001.

Random News Bits: In last month's column I mentioned a rumor about a new printer to compete with the Sanders Technology word-processing dot-matrix printer. The unit has now been formally announced by Florida Data Corporation of West Melbourne, Florida. It offers up to 900 characters per second (cps) speed with correspondence-quality type and high-resolution graphics (at a slower speed). It is said to use a magnetic stored-energy print head, and to offer an almost unlimited choice of type fonts, full graphics, and extended-character format. The machine will be available in the fourth quarter of 1980, and it should be priced under $2000.... Micro Peripherals Incorporated of Salt Lake City, Utah, plans an under-$1000 word-processing printer using a seventeen-wire matrix head and printing at 60 to 75 cps.... In the meantime Diablo, Qume, and Nippon Electric Company (NEC) are rumored to be developing under-$1000 daisy-wheel printers.... Dataproducts will soon introduce a daisy-wheel printer; some observers speculate that it will sell for 20 to 30% less than current daisy-wheel units.... Next year, General Motors (GM) will make much use of on-board microcomputer systems in its vehicles to

Put your applications to work on the Mostek STD-Z80 BUS.



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meet the stringent requirements for emissions control and fuel economy. GM's need for electronic parts will be so great that the company will use 56% of the world's supply of 8 K-byte read-only memories and 40% of the analog-to-digital converters, according to a GM estimate. In all, GM will buy 13 to 15 million electronic parts each day, more than 3 billion parts per year.... Chase Manhattan Bank is developing the Personal Computer Bank Communications System. Any bank customer who has a home terminal or computer system will be able to access (via telephone) his or her account, get an up-to-the-second status report, and cause funds to be transferred. The user with a computer will also be able to do batch-mode transfers and off-line processing of bank account data.... The precursor of flat solid-state data displays may have appeared. Crokroft International of Sunnyvale, California, has introduced a liquid-crystal display (LCD) panel with 32-by-32-dot display. It operates about four times faster than current LCD displays. The company also expects to have a variable-color display in the near future.... For the first time, a microcomputer-software package has been placed on the prestigious *Datamation* magazine Honor Roll of Software Packages. Naturally, the software package was the CP/M operating system, a product of Digital Research. Microsoft BASIC and UCSD Pascal received honorable mention.... A report from International Resource Development, a management consulting firm, predicts that four billion dollars will have been spent on electronic-mail services and equipment by 1990. The field will be dominated by IBM, AT&T, and GT&E, with the US Postal Service getting about one quarter of the business.... A new supercomputer project has been started. Denelcor of Denver, Colorado, is planning to manufacture a computer that uses 50 processors, capable of performing 500 million instructions per second in parallel.... Texas Instruments and Hitachi are developing 64 K-bit programmable memories, which should become available next year....

Court Upholds FCC Ruling On TI Modulator: The District of Columbia Court of Appeals has rejected an appeal by Atari Corporation (see last month's column). Atari challenged the ruling of the Federal Communication Commission (FCC) that allows Texas Instruments (TI) to sell its stand-alone radio-frequency (RF) modulator while the FCC reexamines its own guidelines for electronic television accessories. Atari argued that the FCC should have forced Texas Instruments to abide by the present rules until changes became final. The present regulations prohibit the marketing of stand-alone modulators. Texas Instruments uses these modulators with its Model 99/4 personal computer system.

Radio Shack And Apple Ask FCC For Deadline Extensions: Tandy Corporation (parent company of Radio Shack) and Apple Computer Company have filed separate petitions with the FCC, asking that the FCC's July 1, 1980 deadline for compliance with new radiation standards be extended. They feel that there could be an adverse effect on products still in dealer stocks, which could take 6 to 9 months to sell. All units manufactured after July 1 will have to comply with the standards. General Electric, General Telephone and Electronic (GT&E) Services Corporation, Honeywell, Control Data Corporation, Atari, American Telephone and Telegraph (AT&T), the Computer and Business Equipment Manufacturers Association (CBEMA), and Electronic Industries Association (EIA) have also filed petitions. Most of these petitioners asked for a 2-year extension, while some asked for as many as 7 years.

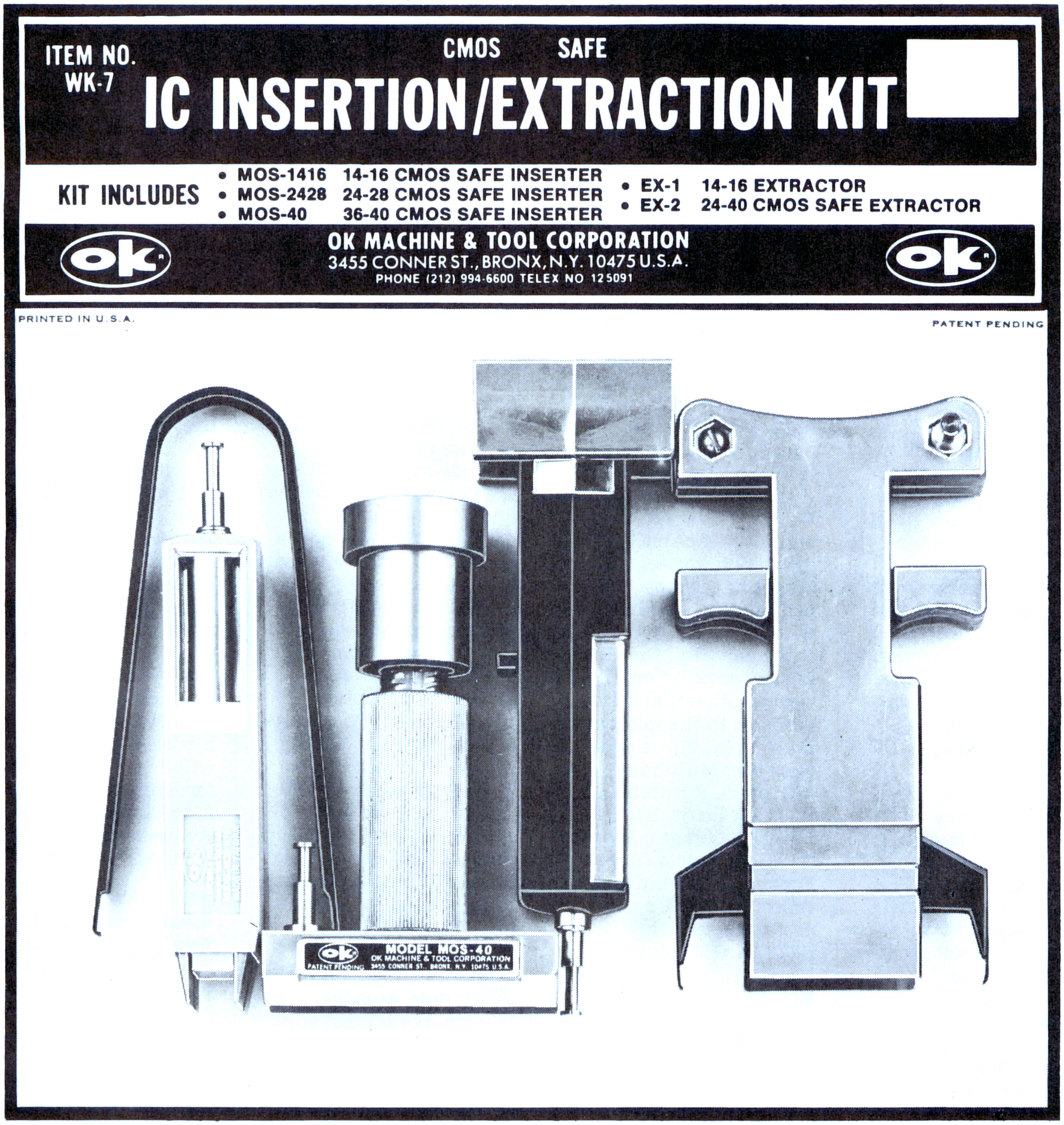
Word-Processing Standard In Development: An American National Standards Institute (ANSI) Group (number 4 of X4A12) has completed a working draft of the page-image format of a word-processor standard. The purpose is to facilitate communications between word processors from different vendors in a common language. The present draft is considered only a first step; the first part of the standard is expected to be adopted by midyear.

Microprocessor Technology Seen Affecting Employment: A report presented at a recent conference of the Organization for Economic Cooperation and Development (OECD) in Paris, France, cited an impact on employment in Japan by microcomputers. The report was prepared by a special committee organized by the Japan Information Processing Development Center and sponsored by the Ministry of International Trade and Industry.

The report forecasts substantial job layoffs due to labor-saving microcomputer-controlled equipment. The biggest effect will be felt in assembly manufacturing where automation will substantially reduce the number of unskilled workers on the assembly line. On the other hand, the report predicted an increased need for systems and software personnel.

Microcomputer Lip-Reader For Deaf: The Research Triangle Institute in North Carolina, working with funds from the National Aeronautics and Space Administration (NASA) and the Veterans Administration, is developing a microprocessor-based system to help the deaf read lips. The device, called Autocuer, can increase a trained lip-reader's comprehension from the typical 25% to about 90%. A light-emitting diode (LED) display projects representations of sounds as nine simple patterns corresponding to the sound.

Commodore Introduces New 4-bit Microprocessor: While other semiconductor makers are going to larger microprocessors (typically 16-bit or enhanced 8-bit devices) Commodore has decided to go in the other direction. Chuck Peddle, the wizard who created the 6502 microprocessor (used in the PET, Apple, Ohio Scientific, Atari, and other computers) and who also created the KIM-1 and PET computers, has now turned his efforts to designing a "super" 4-bit microprocessor called the MCS4500. Using complementary metal-oxide semiconductor (CMOS) technology, it has thirty-four instructions, on-board memory (including 2 K bytes of read-only memory and 176 nybbles of scratch-pad memory), and can directly drive up to four multiplexed liquid-crystal displays (LCDs). Memory can be expanded, and many of



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the features found on 8-bit processors are included. Commodore will offer an assembler and emulator for the device that runs on a PET microcomputer.

IEEE Developing Assembly-Language Standard For Microcomputers: The Institute of Electrical and Electronics Engineers (IEEE) is developing a standard for assembly language on microprocessors (IEEE Task P694/D11). It is long overdue and will be of enormous value to all assembly-language programmers who are struggling to write code for different microprocessors. The group working on the standard has done some genuinely worthwhile things, such as demonstrating that all the current major microprocessors can be handled by a single standard.

The problems of present inconsistency are incredible. For example, in assembly code for some processors, MOV A,B means "move the contents of register B to A," while for others it means just the opposite.

The new IEEE standard should cure problems such as those that occurred when Zilog did not use the Intel mnemonics for the Z80's instructions, which are a superset of the 8080's instructions (probably because Intel copyrighted the mnemonics).

The standard also covers instruction names, address modes, operand sequences, expression evaluation, constants, labels, comments,and assembler directives. The standard does not specify the syntax necessary to support macroinstructions or conditional assembly.

The IEEE Computer Society is to be congratulated for its activities in developing computer standards, which are overcoming problems created by companies that all too often intentionally create incompatibilities to protect their competitive position.

I predict that this assembly-language standard will meet with the wide adoption that the other IEEE standards (such as the IEEE-488 interface and IEEE S-100 bus standards) have met. You can obtain a copy of the Assembly Language Standard draft by sending a self-addressed 10 by 13 inch (25.4 by 33 cm) envelope with $0.54 US postage affixed to Dr Robert G Stewart, Chairman of Computer Standards Committee, IEEE Computer Society, 1658 Belvoir Dr, Los Altos CA 94022.

Incidentally, the IEEE is also working on several other standards relevant to the microcomputer area. These projects are: Multibus, Microbus, Futurebus, Floating Point, High-Level Languages, Pascal and Relocatable Object Format. I will try to report on IEEE's progress in a future BYTELINES column.

Telecomputing Companies Off To A Good Start: The Source, a telecomputing service provided by Telecomputing Corporation of America (or TCA, headquartered in McLean, Virginia), is just six months old. The Source has 3000 subscribers and is adding 500 more per week. The company, which provides information retrieval and software services via a telephone network, has grown to thirty-five employees and a monthly revenue of $100,000. TCA is aiming to have 100,000 customers by the end of 1980.

A competing service called MicroNet, provided by CompuServe Incorporated of Columbus, Ohio, is aimed more at the hobbyist. They claim to have 1200 customers already. However, there is a dark cloud on the horizon, in the form of the Teletext and Viewdata systems now being tested by GT&E, Texas Instruments, and others. This may provide much lower cost but less flexible data access to the home television screen.

Flat CRT Unveiled At CES: Sinclair Radionics demonstrated a prototype of their flat-screen cathode-ray tube (CRT) at the Consumer Electronics Show (CES) held in January. Sinclair hopes to use it in a $125 television receiver to be available in late 1981. The electron gun is mounted sideways, with the beam deflected to strike the phosphor-coated screen. The image is brighter than images on conventional CRTs. The entire receiver will measure 2.5 by 10.2 by 12.7 cm (1 by 4 by 5 inches). The company is doing additional research to develop large-screen and color flat CRTs.

Random Rumors: Centronics, the largest supplier of printers today, will soon cut prices 20 to 30% on existing low-cost printers and will unveil new products directed specifically at the personal computer market, including both impact and nonimpact serial matrix units.... Dataproducts, Okidata, and a number of Japanese manufacturers including NEC are rumored working on multipass, high-density, dot-matrix printers to compete with the RC Sanders Technology Systems Media 12/7 printer. However, at present Sanders Technology has about a 2-year lead time on this technology.... Radio Shack might introduce more than one new personal computer system in the late fall (see the February 1980 column for previous rumors).... Reports have been circulating that Data General is developing a desk-top computer, code-named Wing. It will use a microprocessor, have two floppy-disk drives, and will be made in Taiwan.... It is rumored that Toshiba Electric Company is working on an experimental voice-input typewriter. The unit will be able to type 100,000 to 200,000 different words in Japanese and will recognize words with 90% accuracy. Toshiba recently demonstrated prototype voice-activated television and high-fidelity equipment.... More rumors are surfacing regarding the future plans of Apple Computer Company. Reportedly the new model Apple computer will be a Pascal machine for educational users. Also, Apple will place increased emphasis on the business market....

Congress Considering Two Personal Computer Bills: Did you know that two bills about personal computers have been introduced in Congress? One is H.R.3822, which would set up a national endowment for personal computers. The other is H.R.4326, which would create a presidential commission to make recommendations about the personal computer field.

MAIL: I receive a large number of letters each month as a result of this column. If you wish a response, please include a stamped, self-addressed envelope.

Sol Libes
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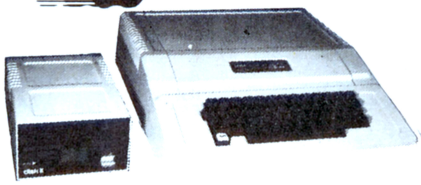

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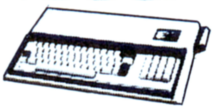

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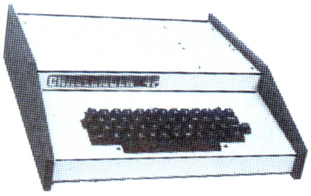

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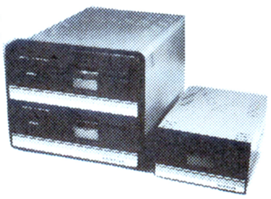

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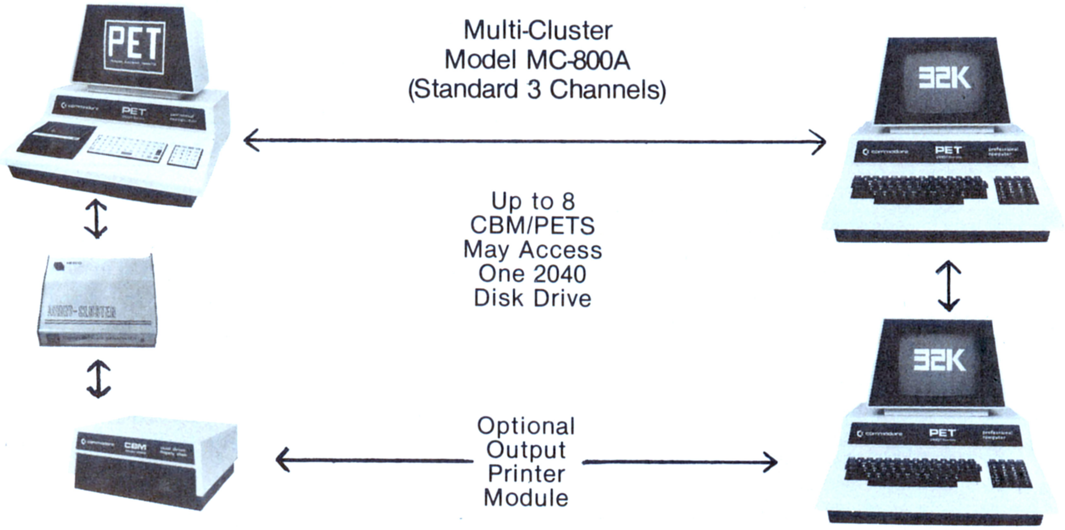
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Technical Forum

Simplifying the Curve-Plotting Calculation by Geometric Means

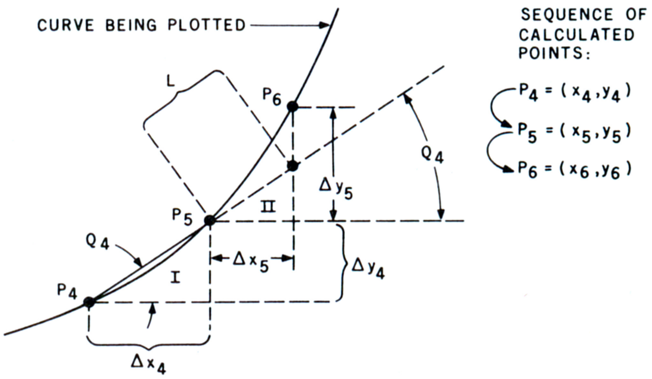
A David Nawrocki, 1101 Wiltshire, San Antonio TX 78209

I enjoyed reading Timothy G Bowker's interesting article "Minimizing Curve-Plotting Calculation" (December 1979 BYTE, page 134). Perhaps it is worth pointing out that his equation (1) on page 138, which involves arctangent and cosine functions, can be reduced to a more efficient form for computational purposes. Although the improvement is slight, the use of a single square-root term will allow more rapid calculation than the trigonometric functions originally used. If a very large number of points must be plotted, the accumulated savings in time can be significant.

First, let us note from the illustration in figure 1 that his $\triangle x_5$ (the quantity to be found) is related by similar triangles (I and II) to $\triangle x_4$, $\triangle y_4$, and L (quantities known from previous steps) as follows:

$$\triangle x_5 = \frac{L\,\triangle x_4}{\sqrt{\triangle x_4^2 + \triangle y_4^2}}$$

The possible scale factors M and N cancel out, and it is not necessary to compute Q_4 to obtain $\triangle x_5$.■



Alpha Locking in Software

W S Lewis, POB 1555, East Canton OH 44730

Those readers of BYTE who are not hardware fanatics can accomplish the same results in software as was obtained by use of hardware in Terry Conboy's article "Alpha Lock for Your ASCII Keyboard" (January 1980 BYTE, page 156). You can let your computer do the work!

In particular, users of the Z80 microprocessor can add 8 bytes of code to the keyboard-input subroutine. The code shown here as listing 1 should appear in the input

Listing 1: *Portion of Z80 code for uppercase to lowercase conversion, input section.*

```
Hexadecimal    Instruction      Comments
Object Code    Mnemonics

  DB 30      XIN IN A,(30H)     ;STATUS PORT
  CB 4F          BIT 1,A
  28 FA          JR Z,XIN
  DB 31          IN A,(31H)     ;KEYBOARD
  CB BF          RES 7,A        ;MASK PARITY
```

Listing 2: *Final portion of Z80 code for uppercase to lowercase conversion.*

```
Hexadecimal    Instruction
Object Code    Mnemonics

  FE 61        CP 61H
  F8           RET M
  FE 7B        CP 7BH
  F0           RET P
  D6 20        SUB 20H
  C9           RET
```

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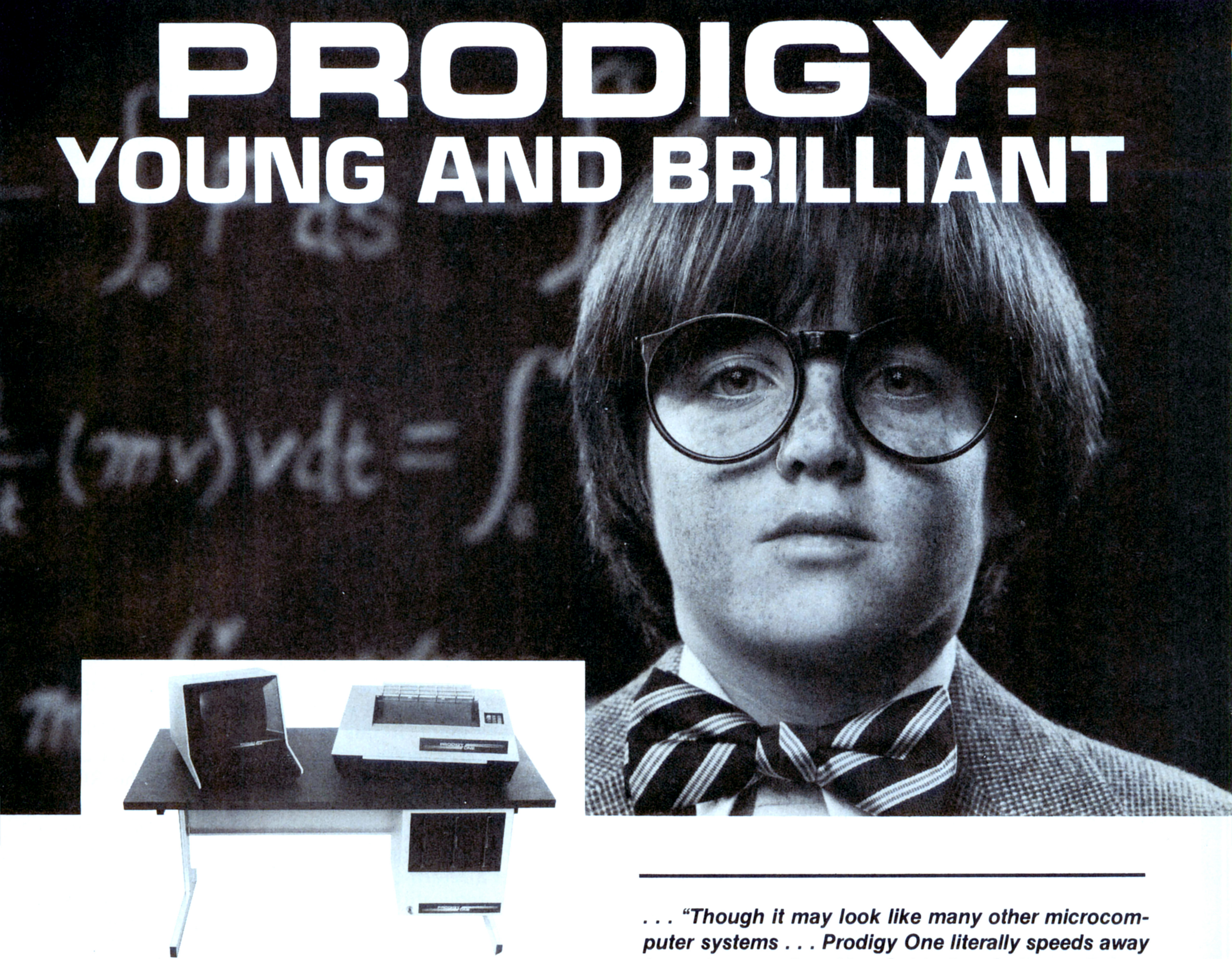

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subroutine. The code in listing 2 goes at the end of the input subroutine, just before it returns to its calling routine.

Note that the uppercase option is completely under software control. The first compare-immediate (the CP 61H) instruction in listing 2 can be changed to a return (RET) instruction when lowercase is desired, and restored to CP when uppercase is desired.■

Maintaining a Single Exit Point

Armond Inselberg, 234 Central Ave, Mountain View CA 94040

I agree with James Lewis, author of "Some Notes on Modular Assembly Programming" (December 1979 BYTE, page 222), in his emphasis on modular programming. However, another important tenet of structured programming is the use of a single entry point and a single exit point for a given program module.

The ABORT routine in the modular 8080 code example of listing 2 (on page 224) violates this principle of having only one exit point. In this case we find that the ABORT routine can be exited by either the JNZ (ie: jump if accumulator is not equal to 0) instruction or by the RET (return from subroutine) instruction.

To apply the single-exit principle to the ABORT routine, we must arrange things such that the RET instruction causes a return either to the monitor or to the main level of the application code. To return to the monitor using RET, we must replace the current return address on the stack with the entry-point address for the monitor.

The top of the stack can be changed with the XTHL instruction, which exchanges the contents of the H and L registers with the top of the stack. The ABORT routine would then be coded:

```
ABORT     LDA SHKEY
          ORA A
          JZ RETURN        ;no shift key request
          LXI H,MONITOR    ;shift key hit
          XTHL             ;exchange stack and HL
RETURN    RET
```

However, my preference is that the return to the monitor never be made at all from the ABORT routine, since ABORT is nested below the main level of code. I would rather proceed as follows.

First, in ABORT, test for the conditions requiring a monitor return, and set up the stack (if necessary) for the return to the monitor. Then, ABORT should set a signal requesting a return to the monitor, and then just return to the main level of the application code. At the main level, either a return to the monitor or a jump to the starting point of the application would be made.

The main level would then be coded:

```
START     CALL RANDOM
          CALL NOTE
          CALL ABORT
          JZ   START        ; no monitor request
          RET               ; monitor return requested.
```
■

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Text continued from page 50:

address in the computer's memory from which the data was written onto the disk. All DTS numbers written on the disk have the bits that indicate the disk-drive number masked to 0 so that the file can be read from any disk drive, regardless of the drive in which it was loaded when it was written.

The *sector trailer* is 4 bytes long. The first 2 bytes contain the check sum. The last 2 bytes, except in the last sector in a file, contain the DTS number of the first sector of the file. In the last sector of the file, the last 2 bytes of the sector trailer contain the address at which execution of the contents of the file begins.

Software: The Basic Disk Routines

The basic disk routines handle head positioning, drive selection, sector selection, motor control, and computation of the check sum. Head positioning is performed by the use of the step and direction bits of the drive-select/status word (hexadecimal location CC03). Since the only indication of the position of the head is the track-0 bit in the drive-select/status word, the position of the head must be kept by software as a value in memory.

> KIMDOS is a KIM-1 compatible version of the Percom MINIDOS disk operating system.

In a multiple-drive disk system, it is desirable to keep track of the head positions of all drives in the system. The drive-selection routine (subroutine DRIV in listing 1) takes care of this. It saves the current track number of the current drive, restores the current track of the desired drive, and latches the desired drive into the controller. KIMDOS reinitializes the track registers (hexadecimal locations 000F thru 0013) with each operation so that preservation of these bytes is not necessary. However, if the system should be expanded with additional software, the track registers become very important. Inadvertant alteration of these locations would cause reading or writing of the wrong track.

In a multiple-drive system, drive motors are either all running or all stopped. The motors cannot be controlled individually since the drive-selection circuitry does not affect the motor-on signal. This necessitates some special handling of drive selection.

The drive-selection routine must insure that the write head is disabled before switching drives, or the area currently under the head of the newly selected drive will be overwritten. The drive-selection routine must also insure that the sector counter on the controller board is synchronized with the newly selected drive. This can be done only after at least one index pulse has been received from the new drive to reset the sector counter.

The sector-selection routine reads the sector number from the controller. It must catch the leading edge of the desired sector so that the read or write operation does not begin in the middle of the sector; it does this by looking for the change from the previous sector to the desired sector. The sector-selection routine detects the disk-missing condition by setting a KIM hardware timer located on one of the 6530 devices for a quarter of a second. If the timer times out before the desired sector is found, the routine assumes that the disk is not properly inserted in the drive.

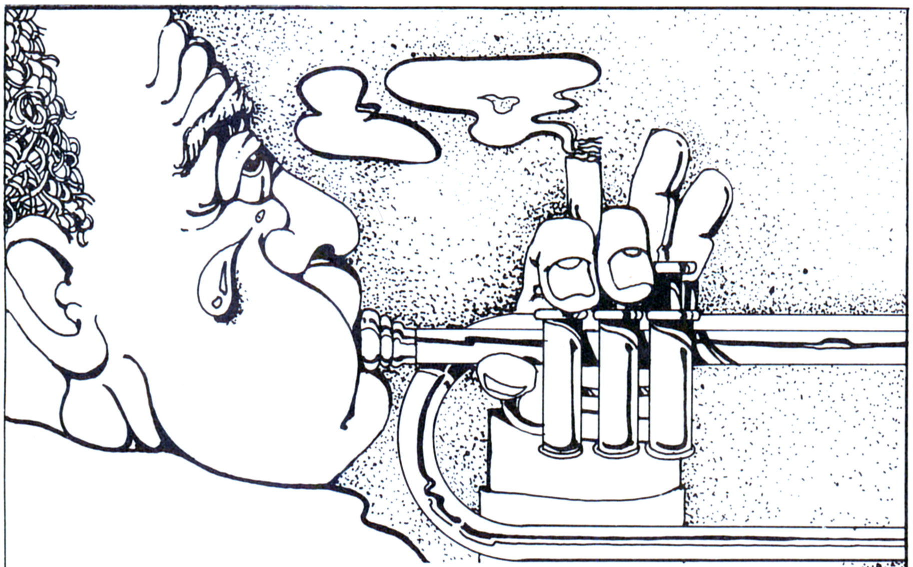
Read and Write Routines

The read and write routines are a fundamental part of KIMDOS, which is given in listing 1. Listing 2 is a cross-reference table for the symbols used in listing 1.

The read routines are designed to automatically try again to read incorrectly read sectors. They will try to read a sector up to six times before reporting a read error. Intermittent errors (such as those caused by random electrical noise, airborne contaminants, slight fluctuations in motor speed, small defects in the written data or track surface, or any combination of the above) can be recovered by rereading the sector.

After a read error, the read routine acts as follows: first, the routine rereads twice. If that fails, the routine moves the head to track 0 and back in an attempt to clear any interfering

Text continued on page 178



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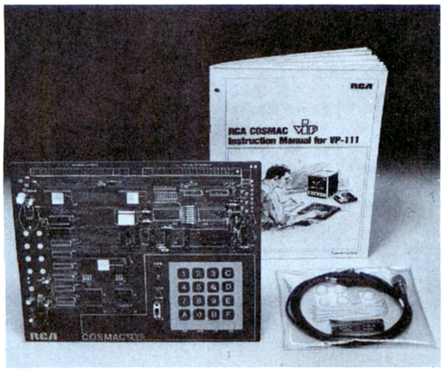

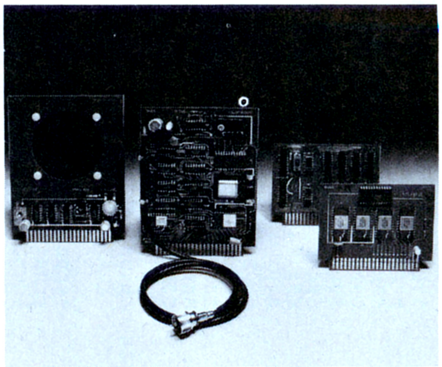

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Listing 1: *KIMDOS, a small disk-operating system for the KIM-1 microcomputer. KIMDOS is a set of disk read and write routines used with a KIM-1 connected to a Percom LFD-400 floppy-disk system. KIMDOS occupies under 1 K bytes of memory (from hexadecimal addresses C000 thru C3FE) and can be stored in one 2708 erasable programmable read-only memory (EPROM). Observe that this listing does not use standard 6502 mnemonics.*

```
Line     Hexadecimal   Object   Label   Instruction   Operand   Commentary
Number   Address       Code             Mnemonic

0001:
0002:                     KIMDOS  -  MINI DOS FOR KIM
0003:
0004:                     VERSION 3  SEPTEMBER 1979
0005:
0006:                     ZERO PAGE STORAGE
0007:
0008:                     01 - 0A IS THE SECTOR HEADER
0009:
0010: C000               KIMDOS ORG   $C000
0011:
0012: C000               DSDR   *     $0000     DESIRED DRIVE
0013: C000               DSTK   *     $0001     AND DESIRED TRACK
0014: C000               DSEC   *     $0002     DESIRED SECTOR
0015: C000               BLTK   *     $0003     BACK LINK TRACK #
0016: C000               BLSC   *     $0004     BACK LINK SECTOR #
0017: C000               FLTK   *     $0005     FORWARD LINK TRACK #
0018: C000               FLSC   *     $0006     FORWARD LINK SECTOR #
0019: C000               LEN    *     $0007     BYTE COUNT (RECORD LENGTH)
0020: C000               TGTP   *     $0008     TARGET ADDRESS
0021: C000               TGTL   *     $0008
0022: C000               TGTH   *     $0009
0023: C000               FTYP   *     $000A     FILE TYPE
0024:
0025:                     0B - 0E IS THE SECTOR TRAILER
0026:
0027: C000               CKSL   *     $000B     THE CHECKSUM
0028: C000               CKSH   *     $000C
0029: C000               PSTL   *     $000D     POSTAMBLE/EXECUTION ADDRESS
0030: C000               PSTH   *     $000E
0031: C000               CRTK   *     $000F     CURRENT TRACK
0032:                     CURRENT TRACK SAVEAREA
0033: C000               CTKP   *     $0010     DRIVE 0
0034: C000               CTKQ   *     $0011     DRIVE 1
0035: C000               CTKR   *     $0012     DRIVE 2
0036: C000               CTKS   *     $0013     DRIVE 3
0037:
0038: C000               DPTR   *     $0014     DATA POINTER
0039: C000               DPTL   *     $0014
0040: C000               DPTH   *     $0015
0041: C000               ALTP   *     $0016     ALTERNATE LOAD POINTER
0042: C000               ALTL   *     $0016
0043: C000               ALTH   *     $0017
0044: C000               TPXH   *     $0018     CKSUM TEMP STORAGE
0045: C000               EXCL   *     $0019     PROGRAM EXECUTION ADDRESS
0046: C000               EXCH   *     $001A
0047: C000               SAVEP  *     $001B
0048: C000               CRDR   *     $001B     CURRENT DRIVE TEMPORARY
0049: C000               HIOR   *     $001B     TEMPORARY STORAGE FOR CDTS
0050: C000               RCNT   *     $001B     READ COUNT TEMPORARY
0051: C000               CKPT   *     $001C     CKSUM POINTER
0052: C000               CKPL   *     $001C
0053: C000               CKPH   *     $001D
0054: C000               DTSA   *     $001C     DRIVE TRACK SAVE
0055: C000               TSSA   *     $001D     TRACK SECTOR SAVE
0056: C000               ENDL   *     $001E     END OF DATA
0057: C000               ENDH   *     $001F
0058:
0059: C000               PCL    *     $00EF     PROGRAM COUNTER SAVE
0060: C000               PCH    *     $00F0
0061: C000               PNTL   *     $00FA     DISPLAY WINDOW
0062: C000               PNTH   *     $00FB
0063:
0064:                     CONTROLLER COMMUNICATION ADDRESSES
0065:
0066:                     INPUT
0067: C000               RDST   *     $CC00     USRT STATUS
0068: C000               RDTA   *     $CC01     RECEIVE DATA
0069: C000               SECT   *     $CC02     SECTOR COUNTER
0070: C000               DVST   *     $CC03     DRIVE STATUS
0071: C000               RRST   *     $CC04     RECEIVER RESTART PULSE
0072: C000               MON    *     $CC05     MOTOR ON PULSE (SEND)
0073: C000               MOFF   *     $CC06     MOTOR OFF PULSE (SEND)
0074:
0075:                     OUTPUT
0076: C000               SYNC   *     $CC00     SYNC WORD
0077: C000               WDTA   *     $CC01     SEND DATA
0078: C000               FILL   *     $CC02     FILL WORD
0079: C000               DTSL   *     $CC03     DRIVE SELECT
0080: C000               WPLS   *     $CC04     WRITE PULSE
0081:
0082:                     OTHER LABELS
0083:
0084: C000               TJX    *     $1705     TIMER START
0085: C000               TOUT   *     $1707     TIME OUT CHECK
0086: C000               STRT   *     $1C4F
0087:
0088:
0089:                     EQUATES
0090:
0091: C000               WRTBIT *     $0008
0092: C000               MTRBIT *     $0004
0093: C000               MILSEC *     $007D
0094: C000               ZERO   *     $0000
0095: C000               DRVMSK *     $00CF
0096: C000               STEPIN *     $0010
0097: C000               SCTMSK *     $000F
0098: C000               HEDLEN *     $000A
0099: C000               TRKMSK *     $003F
0100: C000               TRKLMT *     $0023
0101: C000               SCTBIT *     $0010
0102: C000               STPBIT *     $0020
0103:
0104:
0105:                     ERROR CODES
0106:
0107: C000               DISKMS *     $0000     DISK MISSING
0108: C000               WPROT  *     $0001     WRITE PROTECT
0109: C000               INVSEC *     $0002     INVALID SECTOR #
```

Listing 1 continued on page 162

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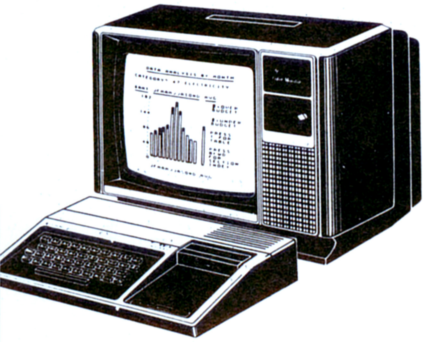

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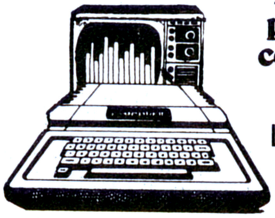

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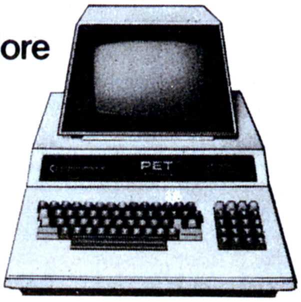

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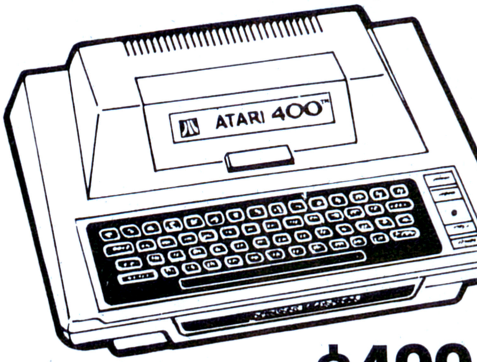

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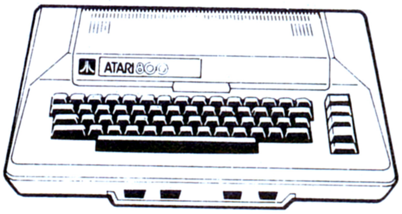

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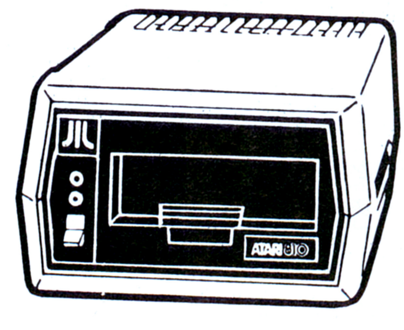

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Circle 97 on inquiry card.

Listing 1 continued:

```
C000           BLNKSC *     $0003     BLANK SECTOR
C000           OVRUN  *     $0004     DISK OVERRUN
C000           READER *     $0005     PERMINENT READ ERROR

                SECTION 1 THE BASIC ROUTINES


                JUMP TABLE

C000 4C AA C1         JMP   RSEX   READ SECTOR
C003 4C CF C2         JMP   WSEX   WHITE SECTOR
C006 4C 7E C2         JMP   SAVX
C009 4C 89 C1         JMP   LODX
C00C 4C BA C0         JMP   PREP
C00F 4C B8 C3         JMP   CVTBIN
C012 4C 90 C3         JMP   CVTDEC
C015 4C 4C C3         JMP   FWDC

                INITDV : INITIALIZE THE TRACK REGISTERS

C018 A9 FF     INITDV LDAIM $FF    OFFLINE CODE
C01A A2 04            LDXIM $04    5 TRACK REGISTERS
C01C 95 0F     INTLUP STAZX CRTK   INIT  A REGISTER
C01E CA               DEX          COUNT
C01F 10 FB            BPL   INTLUP NEXT
C021 60               RTS

                GTKX : MOVE HEAD TO TRACK 0

C022 20 40 C0  GTKX   JSR   TKIN   MOVE IN
C025 20 40 C0         JSR   TKIN
C028 20 38 C0  GETP   JSR   TKOT   MOVE OUT
C02B AD 03 CC         LDA   DVST   TRACK 0?
C02E 4A               LSRA
C02F 4A               LSRA
C030 B0 F6            BCS   GETP   NO
C032 A9 00            LDAIM $00    ZERO CURENT TRACK
C034 85 0F            STAZ  CRTK
C036 F0 47            BEQ   SETL   UNCONDITIONAL BRANCH

                TKIN , TKOT : MOVE HEAD IN OR OUT 1 TRACK

C038 AD 03 CC  TKOT   LDA   DVST   GET DRIVE# IN 2 MSB
C03B 29 CF            ANDIM DRVMSK
C03D 4C 47 C0         JMP   MTVR
C040 AD 03 CC  TKIN   LDA   DVST
C043 29 CF            ANDIM DRVMSK
C045 09 10            ORAIM STEPIN STEP IN BIT
C047 8D 03 CC  MTVR   STA   DTSL   SET DIRECTION
C04A 20 83 C0         JSR   DEL
C04D 09 20            ORAIM STPBIT SET STEP BIT
C04F 8D 03 CC         STA   DTSL
C052 EA               NOP
C053 EA               NOP             STRETCH PULSE WIDTH
C054 EA               NOP
C055 29 DF            ANDIM $DF    RESET STEP BIT
C057 8D 03 CC         STA   DTSL
C05A AD 05 CC         LDA   MON    RETRIGGER MOTOR
C05D 4C 83 C0         JMP   DEL

```

```
                SEEX : MOVE HEAD TO DESIRED TRACK

C060 A5 01     SEEX   LDAZ  DSTK   GET DESIRED TRACK#
C062 29 3F            ANDIM TRKMSK IGNORE DRIVE#
C064 A8               TAY
C065 C4 0F            CPYZ  CRTK   THERE ALREADY?
C067 F0 2B            BEQ   SOUT   YES
C069 90 0B            BCC   STPO   LESS THAN CURRENT
C06B 20 40 C0  STPI   JSR   TKIN   STEP IN
C06E E6 0F            INCZ  CRTK
C070 C4 0F            CPYZ  CRTK   THERE YET?
C072 D0 F7            BNE   STPI   NO
C074 F0 09            BEQ   SETL
C076 20 38 C0  STPO   JSR   TKOT   STEP OUT
C079 C6 0F            DECZ  CRTK
C07B C4 0F            CPYZ  CRTK   THERE YET?
C07D D0 F7            BNE   STPO   NO
C07F A2 1E     SETL   LDXIM $1E    30 MS HEAD SETTLING
C081 D0 02            BNE   DELA

                DELAY 20 MS
C083 A2 14     DEL    LDXIM $14

                DELA : DELAY 1 MILISEC FOR EACH INC OF X

C085 48        DELA   PHA
C086 A9 7D     LUUP   LDAIM MILSEC
C088 8D 05 17         STA   TJX    START TIMER
C08B AD 07 17  LOOP   LDA   TOUT   TIME UP?
C08E F0 FB            BEQ   LOOP   NO
C090 CA               DEX
C091 D0 F3            BNE   LUUP   1 MS PER LOOP
C093 68               PLA
C094 60        SOUT   RTS

                DRVTST : SYNC SECTOR COUNTER TO CURRENT DRIVE

C095 20 31 C1  DRVTST JSR   START  MOTOR
C098 A0 19            LDYIM $19    25 CHANGES
C09A 20 80 C1         JSR   FFTIME SET TIMER
C09D A9 10     DVLUP  LDAIM SCTBIT
C09F 2D 03 CC         AND   DVST   GET SECTOR BIT
C0A2 AE 07 17         LDX   TOUT   TIME UP?
C0A5 D0 0F            BNE   ERRJ   YEP
C0A7 AA               TAX
C0A8 45 1B            EORZ  SAVEP  CHANGE IN SECTOR BIT?
C0AA F0 F1            BEQ   DVLUP  NO, WAIT
C0AC 86 1B            STX   SAVEP  YES SAVE AND COUNT
C0AE 88               DEY
C0AF D0 EC            BNE   DVLUP
C0B1 AD 05 CC  RETRIG LDA   MON    RETRIGGER MOTOR
C0B4 18               CLC
C0B5 60               RTS
C0B6 A9 00     ERRJ   LDAIM DISKMS DISK MISSING
C0B8 38               SEC
C0B9 60               RTS

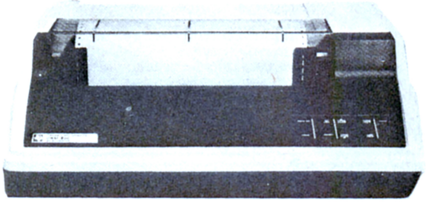

                PREP : SELECT AND PREPARE DRIVE FOR OPERATION

C0BA A5 02     PREP   LDA   DSEC   GET SECTOR
```

```
0231: C0BC CD 0A 0A        CMP   $0A    LESS THAN 10?
0232: C0BF B0 0C           BCS   BADPRM NO , ERROR
0233: C0C1 A5 01           LDA   DSTK   GET TRACK
0234: C0C3 29 3F           ANDIM TRKMSK CLEAR DRIVE
0235: C0C5 C9 23           CMPIM TRKLMT OVERFLOW?
0236: C0C7 90 07           BCC   DRIV   NO, GO CHECK DRIVE
0237: C0C9 A9 04    OVFL   LDAIM OVRUN  YES, ERROR 4
0238: C0CB 38              SEC
0239: C0CC 60              RTS
0240: C0CD A9 02    BADPRM LDAIM INVSEC  INVALID SECTOR
0241: C0CF 60              RTS
0242:
0243: C0D0 AD 03 CC DRIV   LDA   DVST   GET CURRENT DRIVE
0244: C0D3 29 C0           ANDIM $C0
0245: C0D5 85 1B           STAZ  CRDR   SAVE
0246: C0D7 A5 00           LDAZ  DSDR   GET DESIRED DRIVE
0247: C0D9 29 C0           ANDIM $C0
0248: C0DB C5 1B           CMPZ  CRDR   SAME?
0249: C0DD D0 08           BNE   SWIT   NO , SWITCH DRIVES
0250: C0DF A5 0F           LDA   CRTK   GET CURRENT TRK
0251: C0E1 C9 FF           CMPIM $FF    DRIVE INITIALIZED?
0252: C0E3 F0 24           BEQ   DI     NO
0253: C0E5 D0 30           BNE   DS     YES
0254:
0255: C0E7 48       SWIT   PHA
0256: C0E8 A5 1B           LDAZ  CRDR
0257: C0EA 18              CLC
0258: C0EB 2A              ROLA
0259: C0EC 2A              ROLA           ROL DRIVE# TO 2 LSB
0260: C0ED 2A              ROLA
0261: C0EE AA              TAX
0262: C0EF A5 0F           LDAZ  CRTK   SAVE CURRENT TRACK
0263: C0F1 95 10           STAZX CTKP   IN SAVEAREA
0264: C0F3 68              PLA
0265: C0F4 48              PHA
0266: C0F5 18              CLC
0267: C0F6 2A              ROLA
0268: C0F7 2A              ROLA
0269: C0F8 2A              ROLA
0270: C0F9 AA              TAX
0271: C0FA B5 10           LDAZX CTKP   GET CURRENT TRACK
0272: C0FC 85 0F           STAZ  CRTK   FROM SAVEAREA
0273: C0FE A9 08    DA     LDAIM WRTBIT
0274: C100 2C 03 CC DB     BIT   DVST   IS WRITE GATE OFF?
0275: C103 F0 FB           BEQ   DB     NO , THEN WAIT
0276: C105 68              PLA
0277:
0278: C106 8D 03 CC        STA   DTSL   NOW SELECT DRIVE
0279: C109 20 95 C0 DI     JSR   DRVTST SYNC TO DRIVE
0280: C10C B0 10           BCS   DP     ERROR EXIT
0281: C10E A5 0F           LDA   CRTK
0282: C110 C9 FF           CMPIM $FF    DRIVE ONLINE?
0283: C112 D0 03           BNE   DS     YES
0284: C114 20 22 C0        JSR   CTKX   NO , ZERO TRACK
0285: C117 20 31 C1 DS     JSR   START  CHECK MOTOR
0286: C11A 20 60 C0        JSR   SEEX   FIND DESIRED TRACK
0287: C11D 18              CLC
0288: C11E 60       DP     RTS
0289:
0290:                     CKSEC : PART OF GTSC
0291:
0292: C11F AD 07 17 CKSEC  LDA   TOUT   TIME UP?
0293: C122 D0 08           BNE   MISS   YEP
0294: C124 AD 02 CC        LDA   SECT   GET CURRENT SECTOR
0295: C127 29 0F           ANDIM SCTMSK
0296: C129 C5 02           CMP   DSEC   = DESIRED?
0297: C12B 60              RTS
0298: C12C 68       MISS   PLA          RESTORE STACK
0299: C12D 68              PLA
0300: C12E 4C B6 C0        JMP   ERRJ
0301:
0302:                     START : START MOTOR
0303:
0304: C131 A9 04    START  LDAIM MTRBIT
0305: C133 2C 03 CC        BIT   DVST   IS MOTOR ON?
0306: C136 F0 0C           BEQ   STARTR YES
0307: C138 A8              TAY
0308: C139 AD 05 CC        LDA   MON    START IT
0309: C13C A2 00           LDXIM ZERO
0310: C13E 20 85 C0 DELSS  JSR   DELA   THEN WAIT ASEC
0311: C141 88              DEY
0312: C142 D0 FA           BNE   DELSS
0313: C144 4C B1 C0 STARTR JMP   RETRIG
0314:
0315:                     GTSC : WAIT FOR DESIRED SECTOR TO COME AROUND
0316:
0317: C147 78       GTSC   SEI          DISABLE INTERRUPTS
0318: C148 20 80 C1        JSR   FFTIME START TIMER
0319: C14B 20 1F C1 GTLUPA JSR   CKSEC  IF DESIRED IS CURRENT
0320: C14E F0 FB           BEQ   GTLUPA THEN WAIT TILL NXT REV
0321: C150 20 1F C1 GTLUPB JSR   CKSEC  THEN WAIT FOR
0322: C153 D0 FB           BNE   GTLUPB DESIRED
0323: C155 18              CLC
0324: C156 60              RTS
0325:
0326:
0327:                     CRC : COMPUTE CHECKSUM FROM DATA & HEADER
0328:
0329: C157 A5 14    CRC    LDA   DPTL   MOVE DATA PTR
0330: C159 85 1C           STA   CKPL   TO CKSUM PTR
0331: C15B A5 15           LDA   DPTH
0332: C15D 85 1D           STA   CKPH
0333: C15F A6 07           LDXZ  LEN    GET LENGTH
0334: C161 A9 00           LDAIM ZERO   CLEAR SUM
0335: C163 A8              TAY
0336: C164 85 18           STAZ  TPXH   CLEAR TEMP STORAGE
0337: C166 20 72 C1        JSR   CX     COMPUTE DATA SUM
0338: C169 86 1D           STXZ  CKPH   POINT TO HEADER
0339: C16B E8              INX
0340: C16C 86 1C           STXZ  CKPL
0341: C16E A2 0A           LDXIM HEDLEN HEADER LENGTH
0342: C170 A0 00           LDYIM ZERO
0343: C172 51 1C    CX     EORIY CKPT   COMPUTE CKSUM
0344: C174 0A              ASLA
0345: C175 26 18           ROLZ  TPXH
0346: C177 90 02           BCC   CQ
0347: C179 69 00           ADCIM ZERO
0348: C17B C8       CQ     INY
0349: C17C CA              DEX
0350: C17D D0 F3           BNE   CX
0351: C17F 60              RTS
```

Listing 1 continued on page 166

T.I. 810 Printer



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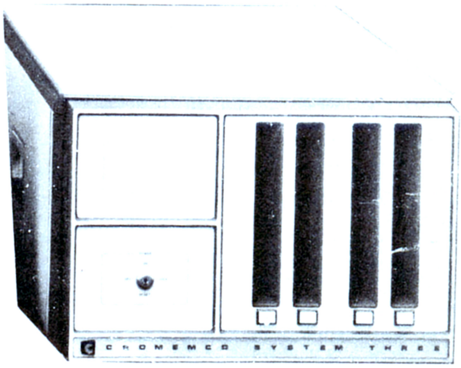

North Star Horizon® 2

32K 4 MHz, dual-drive, with double density controller board, two RS232C serial ports, a parallel port. Included is DOS and North Star Extended Disk BASIC.

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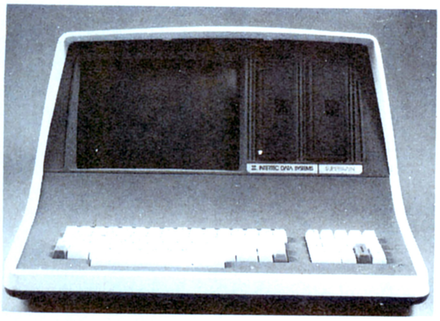

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Listing 1 continued:

```
0352:
0353:                    FFTIME : START TIMER FOR 1/4 SECOND.
0354:                             STORE TWICE FOR 6530 BUG.
0355:
0356: C180 A9 FF      FFTIME LDAIM $FF
0357: C182 8D 07 17   STIMER STA   TOUT
0358: C185 8D 07 17          STA   TOUT
0359: C188 60                RTS
0360:
0361:
0362:
0363:                    SECTION 2 READ ROUTINES
0364:
0365:
0366:
0367:                    LODX : READ A MEMORY FILE FROM DISK
0368:
0369: C189 20 AA C1   LODX   JSR   RSEX   READ A SECTOR
0370: C18C B0 38             BCS   RDRT   PERMINENT ERROR
0371: C18E A5 06             LDAZ  FLSC
0372: C190 D0 06             BNE   NEND   CHECK FOR LAST SECTOR
0373: C192 A5 05             LDAZ  FLTK   (FORWARD LINK ZERO)
0374: C194 F0 0B             BEQ   COPPL  END
0375: C196 A5 06             LDAZ  FLSC
0376: C198 85 02      NEND   STAZ  DSEC   COPY FORWARD LINK TO
0377: C19A A5 05             LDAZ  FLTK   DESIRED TRACK/SECTOR
0378: C19C 85 01             STAZ  DSTK
0379: C19E 4C 89 C1          JMP   LODX   READ NEXT SECTOR
0380: C1A1 A5 0D      COPPL  LDA   PSTL   COPY EXEC ADDRESS
0381: C1A3 85 EF             STA   PCL    TO KIM'S PC
0382: C1A5 A5 0E             LDA   PSTH
0383: C1A7 85 F0             STA   PCH
0384: C1A9 60                RTS
0385:
0386:                    RSEX : READ A SECTOR WITH ERROR RETRY
0387:
0388: C1AA 20 BA C0   RSEX   JSR   PREP   PEPARE DRIV
0389: C1AD B0 17             BCS   RDRT   ERROR EXIT
0390: C1AF 20 C7 C1          JSR   RDS    TRY UP TO 3 TIMES
0391: C1B2 B0 12             BCS   RDRT   ERROR CODE IN A
0392: C1B4 D0 10             BNE   RDRT   SUCCESS
0393: C1B6 20 22 C0          JSR   GTKX
0394: C1B9 20 60 C0          JSR   SEEX   RE-SEEK TRACK
0395: C1BC 20 C7 C1          JSR   RDS    TRY AGAIN
0396: C1BF B0 05             BCS   RDRT
0397: C1C1 D0 03             BNE   RDRT
0398: C1C3 A9 05             LDAIM HEADER READ ERROR
0399: C1C5 38                SEC
0400: C1C6 60         RDRT   RTS
0401:
0402:                    RDS  : READ A SECTOR WITH 2 RETRYS
0403:
0404: C1C7 A9 03      RDS    LDAIM $03    3 TRYS
0405: C1C9 85 1B             STAZ  RCNT
0406: C1CB A9 FB      READ   LDAIM $FB    SYNC CHAR
0407: C1CD 8D 00 CC          STA   SYNC
0408: C1D0 08                PHP           SAVE INTERRUPT
0409: C1D1 20 47 C1          JSR   GTSC   FIND SECTOR
0410: C1D4 B0 0D             BCS   NOSEC
0411: C1D6 A2 1E             LDXIM $1E    SHORT DELAY TO
```

```
0412: C1D8 CA         RQ     DEX           PASS OVER SECTOR BOUNDARY
0413: C1D9 D0 FD             BNE   RQ
0414: C1DB AD 04 CC          LDA   RRST   START RECIEVER
0415: C1DE 20 66 C2          JSR   IN     SKIP SYNC
0416: C1E1 90 03             BCC   ROK    SYNC FOUND
0417: C1E3 28         NOSEC  PLP           RESTORE INTERRUPTS
0418: C1E4 38                SEC
0419: C1E5 60                RTS
0420: C1E6 20 66 C2   ROK    JSR   IN     GET TRACK
0421: C1E9 A8                TAY
0422: C1EA 45 01             EORZ  DSTK   CHECK FOR PROPER TRACK
0423: C1EC 29 3F             ANDIM TRKMSK IGNORE DRIVE
0424: C1EE D0 56             BNE   SKER   SEEK ERR
0425: C1F0 98                TYA
0426: C1F1 85 01             STAZ  DSTK
0427: C1F3 20 66 C2          JSR   IN     GET SECTOR
0428: C1F6 C5 02             CMPZ  DSEC   PROPER SECTOR?
0429: C1F8 D0 4C             BNE   SKER   NO
0430: C1FA A2 00             LDXIM ZERO
0431: C1FC 20 66 C2   HLUP   JSR   IN     GET REST OF HEADER
0432: C1FF 95 03             STAZX BLTK
0433: C201 E8                INX
0434: C202 E0 08             CPXIM $08
0435: C204 D0 F6             BNE   HLUP
0436:                 PREPARE FOR READING DATA
0437:                 DETERMINE WHICH ADDRESS TO USE
0438: C206 A5 17             LDAZ  ALTH
0439: C208 F0 09             BEQ   NOAL
0440: C20A 85 15             STAZ  DPTH   USE ALT IF NON-ZERO
0441: C20C A5 16             LDAZ  ALTL
0442: C20E 85 14             STAZ  DPTL
0443: C210 4C 1B C2          JMP   GDAT
0444: C213 A5 08      NOAL   LDAZ  TGTL   ELSE USE ADDRESS IN HEADER
0445: C215 85 14             STAZ  DPTL
0446: C217 A5 09             LDAZ  TGTH
0447: C219 85 15             STAZ  DPTH
0448: C21B A0 00      GDAT   LDYIM ZERO
0449: C21D AD 00 CC   DALP   LDA   RDST   DATA READY?
0450: C220 4A                LSRA
0451: C221 90 FA             BCC   DALP   NO
0452: C223 AD 01 CC          LDA   RDTA
0453: C226 91 14             STAIY DPTH   SAVE A BYTE
0454: C228 C8                INY
0455: C229 C4 07             CPYZ  LEN
0456: C22B D0 F0             BNE   DALP   READ UNTIL COUNT EXPIRES
0457: C22D A2 00             LDXIM $00
0458: C22F 20 66 C2   CLUP   JSR   IN     GET CHECKSUM
0459: C232 95 0B             STAZX CKSL   AND POSTAMBLE
0460: C234 E8                INX
0461: C235 E0 04             CPXIM $04
0462: C237 D0 F6             BNE   CLUP
0463: C239 20 57 C1          JSR   CRC    COMPUTE CHECKSUM
0464: C23C C5 0B             CMPZ  CKSL   COMPARE WITH ONE READ
0465: C23E D0 06             BNE   SKER
0466: C240 A5 18             LDAZ  TPXH
0467: C242 C5 0C             CMPZ  CKSH
0468: C244 F0 0A             BEQ   SUCC
0469: C246 28         SKER   PLP
0470: C247 C6 1B             DECZ  RCNT   COUNT TRYS
0471: C249 F0 03             BEQ   SERR
0472: C24B 4C CB C1          JMP   READ
```

Listing 1 continued on page 168

Record keeping problems? Our CCA Data Management System solves them easily.

Having information at your fingertips can make your job a whole lot easier. And that's what the CCA Data Management System is all about.

With this Personal Software™ package and an Apple II™ or TRS-80™ disk system, it will be far easier to keep inventories, customer lists, accounts receivable and payable records, patient histories and many more items.

In fact, you can use the CCA DMS for all of your data management needs, rather than buying (expensive) or writing (time consuming) separate programs for each application. That's because DMS lets you create your own filing systems, adapting itself to the types of records you keep. You specify the number and names of each data field—without any programming.

With DMS keeping all of your records, you only have to learn how to use one system. That's easier, too. It's menu driven, with plenty of prompts to help you create files and add, update, scan, inspect, delete, sort, condense and print data. Our comprehensive 130-page step-by-step instruction manual even provides complete "how to" inventory and mailing list applications so you can start processing immediately.

DMS is a very powerful system, with more file and record storage capacity than other data base programs on the market.

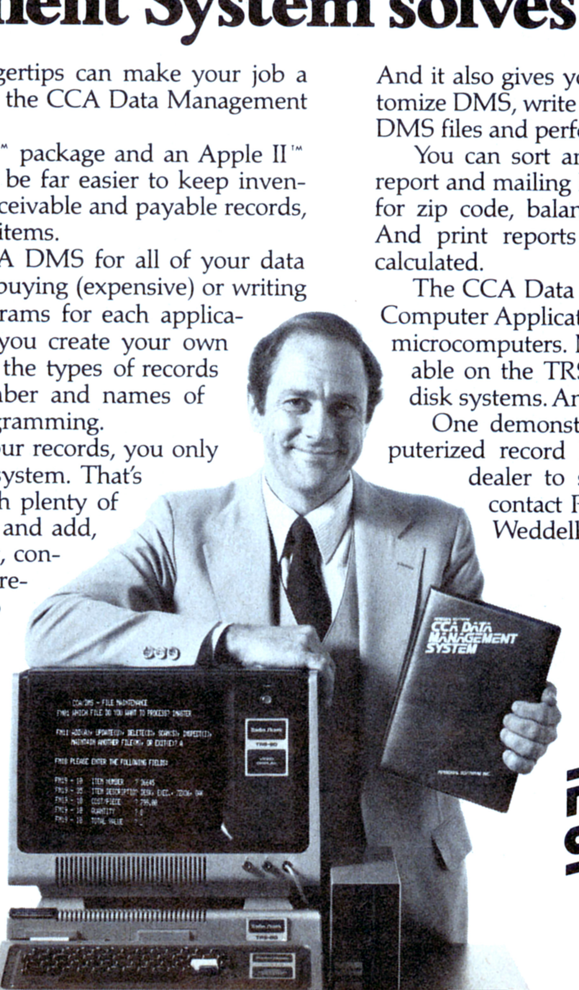
And it also gives you greater data handling flexibility. To customize DMS, write add-on BASIC programs that read or write DMS files and perform any kind of processing you want.

You can sort and print your data in nearly any form of report and mailing label you want. Sort data by up to 10 fields for zip code, balance due, geographic location or whatever. And print reports with subtotals and totals automatically calculated.

The CCA Data Management System, written by Creative Computer Applications, has two years of field testing on other microcomputers. Now Personal Software makes DMS available on the TRS-80 Level II and Apple II and II Plus 48k disk systems. And at under $100, DMS is also easy to afford.

One demonstration will convince you how easy computerized record keeping is. Ask your Personal Software dealer to show you. To locate your nearest dealer, contact Personal Software, Inc., (408) 745-7841, 592 Weddell Dr., Sunnyvale, CA 94086.

See us at NCC booth 48 and 49.



PERSONAL SOFTWARE

*Apple is a trademark of Apple Computer, Inc.; TRS-80 is a trademark of the Radio Shack Div. of Tandy Corp.

Circle 99 on inquiry card.

Listing 1 continued:

```
C24E 18        SERR  CLC              Z FLAG=1 MEANS ERROR
C24F 60              RTS
C250 28        SUCC  PLP                RESTORE INTERRUPT
C251 A5 17           LDAZ  ALTH   ALTERNATE IN USE?
C253 F0 0D           BEQ   NOCQ   NO
C255 A5 07           LDAZ  LEN    YES , UPDATE ALTERNATE
C257 18              CLC
C258 F0 06           BEQ   INCA   00 MEANS 100
C25A 65 16           ADCZ  ALTL
C25C 85 16           STAZ  ALTL
C25E 90 02           BCC   NOCQ
C260 E6 17     INCA  INCZ  ALTH
C262 18        NOCQ  CLC
C263 A9 FF           LDAIM $FF    Z FLAG=0 MEANS GOOD READ
C265 60              RTS

               IN : READ A BYTE AND CHECK FOR OUT OF SECTOR

C266 AD 00 CC  IN    LDA   RDST   DATA READY?
C269 4A              LSRA
C26A B0 0D           BCS   INQ    YES READ IT
C26C AD 02 CC        LDA   SECT   GET SECTOR FROM CONTROLLER
C26F 29 0F           ANDIM $0F
C271 C5 02           CMPZ  DSEC   STILL RIGHT ONE?
C273 F0 F1           BEQ   IN     YES
C275 A9 03           LDAIM BLNKSC EMPTY SECTOR
C277 38              SEC           ERROR FLAG
C278 60              RTS
C279 AD 01 CC  INQ   LDA   RDTA   GET A BYTE
C27C 18              CLC
C27D 60              RTS



               SECTION 3 WRITE ROUTINES



               SAVX : SAVE A FILE ON DISK

C27E A9 00     SAVX  LDAIM ZERO
C280 85 03           STAZ  BLTK   CLEAR BACK LINK
C282 85 04           STAZ  BLSC
C284 A2 01           LDXIM $01
C286 B5 01     KLUP  LDAZX DSTK   COPY TRACK/SECTOR
C288 95 0D           STAZX PSTL   TO POSTAMBLE &
C28A 95 05           STAZX FLTK   FORWARD LINK
C28C CA              DEX
C28D 10 F7           BPL   KLUP
C28F 20 4C C3  SXS   JSR   FWDC   CALC FORWARD LINK
C292 20 2B C3        JSR   LNTH   CALC LENGTH
C295 A5 14           LDA   DPTL   MOVE DATA PTR
C297 85 08           STA   TGTL   TO TARGET
C299 A5 15           LDA   DPTH
C29B 85 09           STA   TGTH
C29D 20 CF C2  SXT   JSR   WSEX   WRITE A SECTOR
C2A0 B0 39           BCS   ERRO
C2A2 A5 07           LDAZ  LEN    GET LENGTH
C2A4 F0 07           BEQ   INCT   00=100
C2A6 18              CLC
```

```
C2A7 65 14           ADCZ  DPTL   UPDATE DATA ADDRESS
C2A9 85 14           STAZ  DPTL
C2AB 90 02           BCC   NOCW
C2AD E6 15     INCT  INCZ  DPTH
C2AF A5 1F     NOCW  LDAZ  ENDH   IF TARGET GREATER
C2B1 C5 15           CMPZ  DPTH   THAN END
C2B3 F0 03           BEQ   CONT
C2B5 B0 09           BCS   SETU
C2B7 60        SRET  RTS            THEN RETURN
C2B8 A5 1E     CONT  LDAZ  ENDL
C2BA C5 14           CMPZ  DPTL
C2BC F0 02           BEQ   SETU
C2BE 90 F7           BCC   SRET
C2C0 A2 01     SETU  LDXIM $01    ELSE PREPARE FOR NEXT SECTOR
C2C2 B5 01     SLUP  LDAZX DSTK   MOVE TRACK/SECTOR TO
C2C4 95 03           STAZX BLTK   BACKWARD LINK
C2C6 B5 05           LDAZX FLTK   MOVE FORWARD LINK
C2C8 95 01           STAZX DSTK   TO TRACK/SECTOR
C2CA CA              DEX
C2CB 10 F5           BPL   SLUP
C2CD 30 C0           BMI   SXS    UNCONDITIONAL

               WSEX : WRITE A SECTOR

C2CF 20 BA C0  WSEX  JSR   PREP   PREPARE DRIVE
C2D2 B0 08           BCS   WSQ    ERROR EXIT
C2D4 A9 01           LDAIM $01
C2D6 2C 03 CC        BIT   DVST   WRITE PROTECT ON?
C2D9 D0 02           BNE   WSR    NO
C2DB 38        ERRO  SEC
C2DC 60        WSQ   RTS
C2DD 20 57 C1  WSR   JSR   CRC    COMPUTE CHECKSUM
C2E0 85 0B           STAZ  CKSL   SAVE IT
C2E2 A5 18           LDAZ  TPXH
C2E4 85 0C           STAZ  CKSH
C2E6 A9 FF           LDAIM $FF    FILL CHAR FOR USRT
C2E8 8D 02 CC        STA   FILL

C2EB 08              PHP          SAVE INTERRUPT STATUS
C2EC 20 47 C1        JSR   CTSC   FIND SECTOR
C2EF B0 37           BCS   WERR
C2F1 8D 04 CC        STA   WPLS   START TRANSMITTER
C2F4 A2 10           LDXIM $10
C2F6 A9 00           LDAIM $00
C2F8 20 63 C3  WSS   JSR   OUT    WRITE LEADER 16 X 00
C2FB CA              DEX
C2FC D0 FA           BNE   WSS
C2FE A9 FB           LDAIM $FB
C300 20 63 C3        JSR   OUT    SEND SYNC
C303 B5 01     WST   LDAZX DSTK   WRITE 10 BYTE HEADER
C305 20 63 C3        JSR   OUT
C308 E8              INX
C309 E0 0A           CPXIM $0A
C30B D0 F6           BNE   WST
C30D A6 07           LDXZ  LEN    GET LENGTH
C30F A0 00           LDYIM $00
C311 B1 14     WSU   LDAIY DPTR   WRITE DATA
C313 20 63 C3        JSR   OUT
C316 C8              INY
C317 CA              DEX
```

Listing 1 continued on page 170

Settle for More from Your TRS-80

BASIC Compiler. With TRS-80 BASIC Compiler, your Level II BASIC programs will run at record speeds! Compiled programs execute an average of 3-10 times faster than programs run under Level II. Make extensive use of integer operations, and get speeds 20-30 times faster than the interpreter.

Best of all, BASIC Compiler does it with BASIC, the language you already know. By compiling the same source code that your current BASIC interprets, BASIC Compiler adds speed with a minimum of effort.

And you get more BASIC features to program with, since features of Microsoft's Version 5.0 BASIC Interpreter are included in the package. Features like the WHILE . . .WEND statement, long variable names, variable length records, and the CALL statement make programming easier. An exclusive BASIC Compiler feature lets you call FORTRAN and machine language subroutines much more easily than in Level II.

Simply type in and debug your program as usual, using the BASIC interpreter. Then enter a command line telling the computer what to compile and what options to use.

Voila! Highly optimized, Z-80 machine code that your computer executes in a flash! Run it now or save it for later. Your compiled program can be saved on disk for direct execution every time.

Want to market your programs? Compiled versions are ideal for distribution.* You distribute only the object code, not the source, so your genius stays fully protected.

BASIC Compiler runs on your TRS-80 Model I with 48K and disk drive. The package includes BASIC Compiler, linking loader and BASIC library with complete documentation. $195.00.

*Microsoft royalty information for the sale of programs compiled with BASIC Compiler is available from Microsoft.

MORE
FROM
MICROSOFT

muMATH Symbolic Math System expands your TRS-80 beyond the limits of numerical evaluation to a much higher level of math sophistication.

Symbolic mathematics is muMATH's power. For the first time, algebra, trigonometry, calculus, integration, differentiation and more can be performed on a system smaller than an IBM 370. And in a fraction of the time you could do them manually.

Yet for all its power, muMATH is simple to use.

To perform a differentiation you could enter: ?DIF (A*X ↑ 3 + SIN(X ↑ 2),X);

In almost no time, the computer would reply with: @2*X*COS(X ↑ 2) + 3*A*X ↑ 2.

Or to add fractions: ?1/3 + 5/6 + 2/5 + 3/7;

The instantaneous answer: 419/210.

Or to perform a more difficult trigonometric expansion you enter: SIN(2*Y)*(4*COS(X)↑3—COS (3*X) + SIN (Y)*(COS(X+Y+#PI) — COS(X—Y));

Just a few seconds later, the computer replies: @4*SIN(Y)*COS(X)*COS(Y).

muMATH has virtually infinite precision with full accuracy up to 611 digits.

If you use math, you'll find countless ways to save time and effort with muMATH. It's a professional tool for engineers and scientists. A learning tool for students at any level from algebra to calculus.

And if you want to expand your capabilities even beyond the standard muMATH, the option is open. muSIMP, the programming language in which muMATH is written, is included in the muMATH package. A superset of the language LISP, muSIMP is designed especially for interactive symbolic mathematics and other artificial intelligence applications.

muMATH and muSIMP were written by The Soft Warehouse, Honolulu, Hawaii. Priced at $74.95, the package includes muMATH, muSIMP and a complete manual. It requires a Model I TRS-80 with 32K and single disk. muMATH for the Apple II Computer will be available later this year.

You can buy muMATH and BASIC Compiler at computer stores across the country that carry Microsoft products. If your local store doesn't have them, call us. 206-454-1315. Or write Microsoft Consumer Products, 10800 Northeast Eighth, Suite 507, Bellevue, WA 98004.

MICROSOFT
CONSUMER PRODUCTS

Circle 100 on inquiry card.

Listing 1 continued:

```
0593: C318 D0 F7              BNE    WSU
0594: C31A A0 04              LDYIM  $04
0595: C31C B5 08        WSV   LDAZX  CKSL    WRITE CHECKSUM & POSTAMBLE
0596: C31E 20 63 C3           JSR    OUT
0597: C321 E8                 INX
0598: C322 88                 DEY
0599: C323 D0 F7              BNE    WSV
0600: C325 28                 PLP            RESTORE INTERRUPT
0601:
0602: C326 18                 CLC
0603: C327 60                 RTS
0604: C328 28           WERR  PLP            RESTORE INTERRUPTS
0605: C329 38                 SEC
0606: C32A 60                 RTS
0607:
0608:                    LNTH : COMPUTE LENGTH AND FIND LAST BLOCK
0609:
0610: C32B A5 1E        LNTH  LDAZ   ENDL    SUBTRACT TARGET
0611: C32D 38                 SEC
0612: C32E E5 14              SBCZ   DPTL    FROM END
0613: C330 85 07              STAZ   LEN     TO GET LENGTH
0614: C332 A5 1F              LDAZ   ENDH
0615: C334 E5 15              SBCZ   DPTH    LAST BLOCK?
0616: C336 F0 05              BEQ    LQ      YES
0617: C338 A9 00              LDAIM  $00     NO THEN LENGTH=100
0618: C33A 85 07              STAZ   LEN
0619: C33C 60                 RTS
0620: C33D E6 07        LQ    INCZ   LEN
0621: C33F 85 05              STAZ   FLTK    LAST BLOCK
0622: C341 85 06              STAZ   FLSC    CLEAR FORWARD LINK
0623: C343 A5 19              LDAZ   EXCL
0624: C345 85 0D              STAZ   PSTL    MOVE EXECUTION ADDRESS
0625: C347 A5 1A              LDAZ   EXCH
0626: C349 85 0E              STAZ   PSTH
0627: C34B 60                 RTS
0628:
0629:                    FWDC : CALCULATE FORWARD LINK. ASSUMES
0630:                           FLTK =CURRENT TRACK
0631:
0632: C34C A5 06        FWDC  LDAZ   FLSC    GET CURRENT SECTOR
0633: C34E C9 08              CMPIM  $08     FIND NEXT ALTERNATE
0634: C350 F0 0C              BEQ    FR      IF NOT 8
0635: C352 B0 04              BCS    FQ      OR 9
0636: C354 69 02              ADCIM  $02     THEN ADD 2
0637: C356 D0 08              BNE    FS      UNCONDITIONAL
0638: C358 E6 05        FQ    INCZ   FLTK    NEXT TRACK
0639: C35A A9 00              LDAIM  $00     FIRST SECTOR
0640: C35C F0 02              BEQ    FS      UNCONDITIONAL
0641: C35E A9 01        FR    LDAIM  $01
0642: C360 85 06        FS    STAZ   FLSC    NEXT SECTOR
0643: C362 60                 RTS
0644:
0645:                    OUT  : SEND A BYTE WHEN USRT IS READY
0646:
0647: C363 48           OUT   PHA
0648: C364 AD 00 CC     OUTQ  LDA    RDST    USRT READY?
0649: C367 10 FB              BPL    OUTQ    NO, WAIT
0650: C369 68                 PLA
0651: C36A 8D 01 CC           STA    WDTA    SEND A BYTE
0652: C36D 60                 RTS
0653:
```

```
0654:
0655:
0656:                  SECTION 4 KEYBOARD CONTROL ROUTINES
0657:
0658:
0659:
0660:                  SAVK : ENTRY TO WRITE FILE
0661:                         ENTER THE FOLLOWING VIA KIM:
0662:                         BEGINNING ADDRESS       14,15
0663:                         ENDING ADDRESS          1E,1F
0664:                         EXECUTION ADDRESS       19,1A
0665:                         DRIVE/TRACK/SECTOR      1C,1D
0666:                         FILE TYPE               0A
0667:
0668: C36E 20 B5 C3  SAVK   JSR    INTCVT INIT AND CONVERT
0669: C371 B0 15            BCS    KERR   ERROR
0670: C373 20 7E C2         JSR    SAVX   WRITE FILE
0671: C376 B0 10            BCS    KERR
0672: C378 20 90 C3  LAST   JSR    CVTDEC CONVERT D/T/S
0673: C37B 4C 4F 1C  KIMQ   JMP    STRT   RETURN TO KIM
0674:
0675:                  LODK : READ A MEMORY FILE
0676:                         ENTER THE FOLLOWING
0677:                         DRIVE/TRACK/SECTOR      1C,1D
0678:                         ALTERNATE TARGET OR 0 16,17
0679:
0680: C37E 20 B5 C3  LODK   JSR    INTCVT INIT AND CONVERT
0681: C381 B0 05            BCS    KERR
0682: C383 20 89 C1         JSR    LODX   READ FILE
0683: C386 90 F0            BCC    LAST   SHOW LAST TRK/SECTOR
0684:
0685: C388 85 FA     KERR   STAZ   PNTL   ERROR CODE TO DISPLAY
0686: C38A A9 FF            LDAIM  $FF    ERROR FLAG
0687: C38C 85 FB            STAZ   PNTH
0688: C38E D0 EB            BNE    KIMQ
0689:
0690:                  CVTDEC : CONVERT TRACK/SECTOR FOR DISPLAY
0691:
0692: C390 A9 FF     CVTDEC LDAIM  $FF    ZERO COUNTE?
0693: C392 85 FB            STAZ   PNTH
0694: C394 A5 01            LDAZ   DSTK   GET TRACK #
0695: C396 29 3F            ANDIM  TRKMSK IGNORE DRIVE#
0696: C398 38               SEC
0697: C399 E6 FB     LSQ    INCZ   PNTH
0698: C39B E9 0A            SBCIM  $0A    DIVIDE BY 10 LOOP
0699: C39D B0 FA            BCS    LSQ    BRANCH NO BORROW
0700: C39F 69 0A            ADCIM  $0A    REMAINDER IN A
0701: C3A1 48               PHA
0702: C3A2 A5 02            LDAZ   DSEC   CONVERT ALTERNATE TO
0703: C3A4 4A               LSRA
0704: C3A5 90 02            BCC    KSS    TO SEQUENTIAL SECTOR
0705: C3A7 69 04            ADCIM  $04    ADD 4 + CARRY
0706: C3A9 85 FA     KSS    STAZ   PNTL   SAVE
0707: C3AB 68               PLA
0708: C3AC 0A               ASLA
0709: C3AD 0A               ASLA
0710: C3AE 0A               ASLA
0711: C3AF 0A               ASLA
0712: C3B0 05 FA            ORAZ   PNTL   MERGE TRACK LSB
0713: C3B2 85 FA            STAZ   PNTL   WITH SECTOR
0714: C3B4 60               RTS
```

Listing 1 continued on page 172

NEECO PROUDLY INTRODUCES

COMMODORE'S NEW 8000 SERIES (80 column) COMPUTERS

80
COLUMNS
Model 8032

CBM™ 8000 SERIES BUSINESS COMPUTERS

The new Commodore 8000 series computers offer a wide screen display to show you up to 80-character lines of information. Text editing and report formatting are faster and easier with the new wide-screen display. The 8000 series also provides a resident Operating System with expanded functional capabilities. You can use BASIC on the 8000 computers in both interactive and program modes, with expanded commands and functions for arithmetic, editing, and disk file management. The CBM 8000 series computers are ideally suited for the computing needs of the business marketplace.

SCREEN
2000 character display, organized into twenty-five 80-column lines
64 ASCII, 64 graphic characters
3 x 8 dot matrix characters
Green phosphor screen
Brightness control
Line spacing: 1½ in Text Mode
1 in Graphics Mode

KEYBOARD
73-key typewriter style keyboard with graphic capabilities
Repeat key functional with all keys

MEMORY
CBM 8016: 16K (15359 net) random access memory (RAM)
CBM 8032: 32K (31743 net) random access memory (RAM)

POWER REQUIREMENTS
Volts: 110V
Cycles: 60 Hz
Watts: 100

SCREEN EDITING CAPABILITIES
Full cursor control (up, down, right, left)
Character insert and delete
Reverse character fields
Overstriking
Return key sends entire line to CPU regardless of cursor position

INPUT/OUTPUT
Parallel port
IEEE-488 bus
2 cassette ports
Memory and I/O expansion connectors

FIRMWARE
24K or ROM contains:
BASIC (version 4.0) with direct (interactive) and indirect (program) modes
9-digit floating binary arithmetic
Tape and disk file handling software

The 8000 Series will be available May/June '80

Model 8016	Model 8032	2040 Dual Floppy
$1495	**$1795**	**$1295**

commodore
CBM
Model 2040
dual drive
floppy disk

$1695 (available May/June '80)

CBM™ 8050 DUAL DRIVE FLOPPY DISK

The CBM 8050 Dual Drive Floppy Disk in an enhanced version of the intelligent CBM 2040 Disk Drive. The CBM 8050 has all of the features of the CBM 2040, and provides more powerful software capabilities, as well as nearly one megabyte of online storage capacity. The CBM 8050 supplies relative record files and automatic diskette initialization. It can copy all the files from one diskette to another without copying unused space. The CBM 8050 also offers improved error recovery and the ability to append to sequential files.

HARDWARE SPECIFICATIONS
Dual Drives
Two microprocessors
974K Bytes storage on two 5.25" diskettes (ss)
Tracks 70
Sectors 17-21
Soft sector format
IEEE-488 interface
Combination power (green) and error (red) indicator lights
Drive Activity indicator lights
Disk Operating System Firmware (12K ROM)
Disk Buffer (4K RAM)

FIRMWARE
DOS version 2.0
Sequential file manipulation
Sequential user files
Relative record files
Append to sequential files
Improved error recovery
Automatic diskette initialization
Automatic directory search
Command parser for syntax validation
Program load and save

Available June/July

$395

CBM™ IEEE MODEM

SPECIFICATIONS
- *Full or half duplex operation
- *300 bits per second
- *Standard IEEE 488 interface
- *Switch selectable originate, off, answer-full duplex, test, half duplex
- *Visible indicators are transmit data, receive data, carrier ready, test
- *Frequency shifted modulation
- *Bell 103/113 compatible

"Exceptional performance - even on noisy phone lines"

*CBM is a registered trademark of Commodore. All prices and specifications are subject to change without notice.

NEECO
679 Highland Ave.
Needham, MA
02194

Mon-Fri 9:30-5:30
MasterCharge &
Visa Accepted
(617) 449-1760
Telex: 951021

MICROAMERICA DISTRIBUTING
"Nationwide distributors of Computer Equipment"
21 Putnam Street
Needham, MA
02194
(617) 449-4310

Circle 101 for microamerica Circle 102 for NEECO

Listing 1 continued:

```
0715:
0716:                       CVTBIN : CONVERT DECIMAL DRIVE/TRACK/SECTOR
0717:                                TO INTERNAL FORMAT
0718:
0719: C3B5 20 18 C0  INTCVT JSR   INITDV INIT AND CONVERT
0720:
0721: C3B8 A5 1D     CVTBIN LDA   TSSA
0722: C3BA 29 0F            ANDIM SCTMSK EXTRACT SECTOR
0723: C3BC C9 0A            CMPIM $0A    VALID?
0724: C3BE B0 3C            BCS   INVS   NO
0725:                 CONVERT IT TO ALTERNATING SECTOR
0726: C3C0 C9 05            CMPIM $05    LESS THAN 5?
0727: C3C2 90 08            BCC   CDQ    YES
0728: C3C4 38               SEC
0729: C3C5 E9 05            SBCIM $05    MINUS 5
0730: C3C7 0A               ASLA          MULTIPLY BY 2
0731: C3C8 69 01            ADCIM $01    ADD 1
0732: C3CA D0 01            BNE   CDR    UNCONDITONAL
0733: C3CC 0A        CDQ    ASLA          MULTIPLY BY 2
0734: C3CD 85 02     CDR    STAZ  DSEC   SAVE SECTOR
0735: C3CF A5 1D            LDAZ  TSSA   GET HIGH NYBBLE
0736: C3D1 4A               LSRA
0737: C3D2 4A               LSRA
0738: C3D3 4A               LSRA
0739: C3D4 4A               LSRA
0740: C3D5 C9 0A            CMPIM $0A    VALID?
0741: C3D7 B0 23            BCS   INVS   NO
0742: C3D9 85 01            STAZ  DSTK   SAVE LOW ORDER TRACK #
0743:                 MULTIPLY HI ORDER TRACK BY 10
0744: C3DB A5 1C            LDAZ  DTSA
0745: C3DD 29 0F            ANDIM $0F    CLEAR DRIVE #
0746: C3DF 85 1B            STAZ  HIOR   SAVE
0747: C3E1 0A               ASLA          MULTIPLY BY 4
0748: C3E2 0A               ASLA
0749: C3E3 18               CLC
0750: C3E4 65 1B            ADCZ  HIOR   ADD ONCE (5X)
0751: C3E6 0A               ASLA          MULTIPLY BY 2 (10X)
0752: C3E7 65 01            ADCZ  DSTK   ADD LOW ORDER
0753: C3E9 C9 23            CMPIM TRKLMT
0754: C3EB B0 0F            BCS   INVS
0755: C3ED 85 01            STAZ  DSTK
0756: C3EF A5 1C            LDAZ  DTSA
0757: C3F1 29 F0            ANDIM $F0    GET DRIVE #
0758: C3F3 C9 40            CMPIM $40
0759: C3F5 B0 05            BCS   INVS
0760: C3F7 0A               ASLA
0761: C3F8 0A               ASLA
0762: C3F9 85 00            STAZ  DSDR
0763: C3FB 60               RTS
0764:
0765: C3FC A9 02     INVS   LDAIM $02    INVALID SECTOR
0766: C3FE 60        THEEND RTS
0767:
    ALTH   0017    ALTL   0016    ALTP   0016    BADPRM C0CD
    BLNKSC 0003    BLSC   0004    BLTK   0003    CDQ    C3CC
    CDR    C3CD    CKPH   001D    CKPL   001C    CKPT   001C
    CKSEC  C11F    CKSH   000C    CKSL   000B    CLUP   C22F
    CONT   C2B8    COPPL  C1A1    CQ     C17B    CRC    C157
```

```
CRDR   001B    CRTK   000F    CTKP   0010    CTKQ   0011
CTKR   0012    CTKS   0013    CVTBIN C3B8    CVTDEC C390
CX     C172    DA     C0FE    DALP   C21D    DB     C100
DELA   C085    DELSS  C13E    DEL    C083    DI     C109
DISKMS 0000    DP     C11E    DPTH   0015    DPTL   0014
DPTR   0014    DRIV   C0D0    DRVMSK 00CF    DRVTST C095
DS     C117    DSDR   0000    DSEC   0002    DSTK   0001
DTSA   001C    DTSL   CC03    DVLUP  C09D    DVST   CC03
ENDH   001F    ENDL   001E    ERRJ   C0F6    ERRO   C2DB
EXCH   001A    EXCL   0019    FFTIME C180    FILL   CC02
FLSC   0006    FLTK   0005    FQ     C358    FR     C35E
FS     C360    FTYP   000A    FWDC   C34C    GDAT   C21B
GETP   C028    GTKX   C022    GTLUPA C14B    GTLUPB C150
GTSC   C147    HEDLEN 000A    HIOR   001B    HLUP   C1FC
IN     C266    INCA   C260    INCT   C2AD    INITDV C018
INQ    C279    INTCVT C3B5    INTLUP C01C    INVS   C3FC
INVSEC 0002    KERR   C388    KIMDOS C000    KIMQ   C37B
KLUP   C286    KSS    C3A9    LAST   C378    LEN    0007
LNTH   C32B    LODK   C37E    LODX   C189    LOOP   C08B
LQ     C33D    LSQ    C399    LUUP   C086    MILSEC 007D
MISS   C12C    MOFF   CC06    MON    CC05    MTRBIT 0004
MTVR   C047    NEND   C198    NOAL   C213    NOCQ   C262
NOCW   C2AF    NOSEC  C1E3    OUTQ   C364    OUT    C363
OVFL   C0C9    OVRUN  0004    PCH    00F0    PCL    00EF
PNTH   00FB    PNTL   00FA    PREP   C0BA    PSTH   000E
PSTL   000D    RCNT   001B    RDRT   C1C6    RDST   CC00
RDS    C1C7    RDTA   CC01    READ   C1CB    READER 0005
RETRIG C0B1    ROK    C1E6    RQ     C1D8    RRST   CC04
RSEX   C1AA    SAVEP  001B    SAVK   C36E    SAVX   C27E
SCTBIT 0010    SCTMSK 000F    SECT   CC02    SEEX   C060
SERR   C24E    SETL   C07F    SETU   C2C0    SKER   C246
SLUP   C2C2    SOUT   C094    SRET   C2B7    START  C131
STARTR C144    STEPIN 0010    STIMER C182    STPBIT 0020
STPI   C06B    STPO   C076    STRT   1C4F    SUCC   C250
SWIT   C0E7    SXS    C28F    SXT    C29D    SYNC   CC09
TGTH   0009    TGTL   0008    TGTP   0008    THEEND C3FE
TJX    1705    TKIN   C040    TKOT   C038    TOUT   1707
TPXH   0018    TRKLMT 0023    TRKMSK 003F    TSSA   001D
WDTA   CC01    WERR   C328    WPLS   CC04    WPROT  0001
WRTBIT 0008    WSEX   C2CF    WSQ    C2DC    WSR    C2DD
WSS    C2F8    WST    C303    WSU    C311    WSV    C31C
ZERO   0000
```

Listing 2: *Cross-reference table for the symbols in listing 1.*

```
SYMBOL          DEFINED        REFERENCES
ALTH             43             438  476  484
ALTL             42             441  481  482
ALTP             41
BADPRM           240             232
BLNKSC           110             498
BLSC             16              515
BLTK             15              432  514  548
CDQ              733             727
CDR              734             732
CKPH             53              332  338
CKPL             52              330  340
CKPT             51              343
CKSEC            292
CKSH             28              467  567
CKSL             27              459  464  565  595
CLUP             458             462
CONT             542             539
COPPL            380             374
CQ               348             346
CRC              329             463  564
CRDR             48              245  248  256
CRTK             31              147  175  179  180  184  185  250
                                 262  272  281
CTKP             33              263  271
CTKQ             34
CTKR             35
CTKS             36
CVTBIN           721             124
CVTDEC           692             125  672
CX               343             337  350
DA               273
DALP             449             451  456
DB               274             275
DEL              191             159  168
DELA             195             188  310
DELSS            310             312
DI               279             252
DISKMS           107             223
DP               288             280
DPTH             40              331  440  447  526  536  538  615
DPTL             39              329  442  445  524  533  534  543
                                 612
DPTR             38              453  589
DRIV             243             236
DRVMSK           95              153  156
DRVTST           207             279
DS               285             253  283
DSDR             12              246  762
DSEC             14              230  296  376  428  496  702  734
DSTK             13              172  233  378  422  426  517  547
                                 550  582  694  742  752  755
DTSA             54              744  756
DTSL             79              158  161  166  278
```

```
DVLUP            210             216  219
DVST             70              142  152  155  211  243  274  305
                                 560
ENDH             57              537  614
ENDL             56              542  610
ERRJ             223             213  300
ERRO             562             529
EXCH             46              625
EXCL             45              623
FFTIME           356             209  318
FILL             78              569
FLSC             18              371  375  622  632  642
FLTK             17              373  377  519  549  621  638
FQ               638             635
FR               641             634
FS               642             637  640
FTYP             23
FWDC             632             126  522
GDAT             448             443
GETP             141             145
GTKX             139             284  393
GTLUPA           319             320
GTLUPB           321             322
GTSC             317             409  572
HEDLEN           98              341
HIOR             49              746  750
HLUP             431             435
IN               491             415  420  427  431  458  497
INCA             484             480
INCT             536             531
INITDV           130
INQ              501             493
INTCVT           719             668  680
INTLUP           132             134
INVS             765             724  741  754  759
INVSEC           109
KERR             685             669  671  681
KIMDOS           10
KIMQ             673             688
KLUP             517             521
KSS              706             704
LAST             672             683
LEN              19              333  455  478  530  587  613  618
                                 620
LNTH             610             523
LODK             680
LODX             369             122  379  682
LOOP             198             199
LQ               620             616
LSQ              697             699
LUUP             196             201
MILSEC           93              196
MISS             298             293
MOFF             73
MON              72              167  308
MTRBIT           92              304
```

Listing 2 continued on page 176

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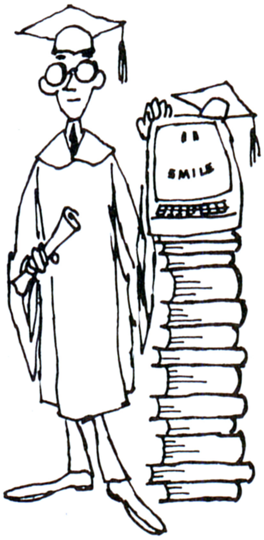

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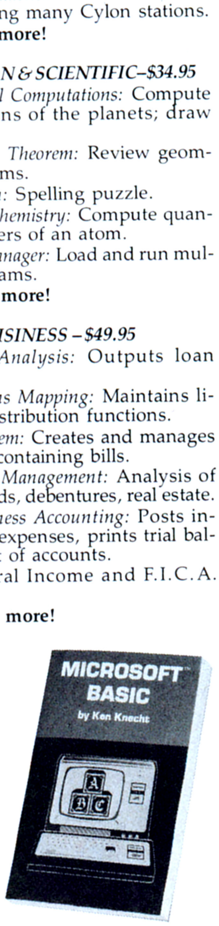

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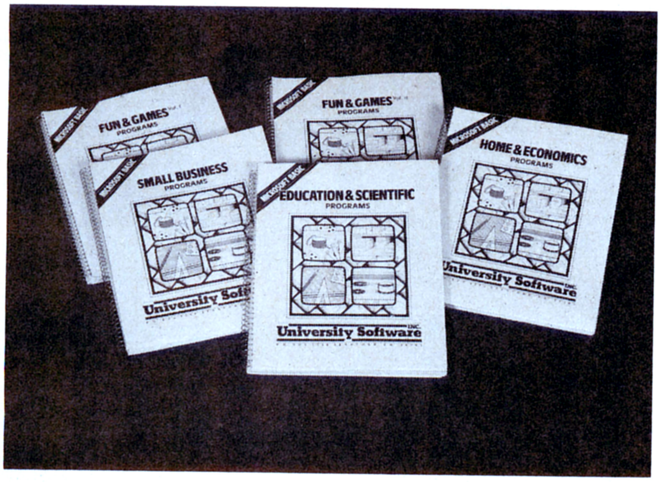

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Listing 2 continued:

```
MTVR       158    154
NEND       376    372
NOAL       444    439
NOCQ       485    477  483
NOCW       537    535
NOSEC      417    410
OUT        647    577  581  583  590  596
OUTQ       648    649
OVFL       237
OVRUN      111    237
PCH        60     383
PCL        59     381
PNTH       62     687  693  697
PNTL       61     685  706  712  713
PREP       230    123  380  557
PSTH       30     382  626
PSTL       29     380  518  624
RCNT       50     405  470
RDRT       400    370  389  391  392  396  397
RDS        404    390  395
RDST       67     449  491  648
RDTA       68     452  501
READ       406    472
READER     112    398
RETRIG     220
ROK        420    416
RQ         412    413
RRST       71     414
RSEX       388    119  369
SAVEP      47     215  217
SAVK       668
SAVX       513    121  670
SCTBIT     101    210
SCTMSK     97     295  722
SECT       69     294  494
SEEX       172    286  394
SERR       473    471
SETL       187    148  182
SETU       546    540  544
SKER       469    424  429  465
SLUP       547    552
SOUT       203    176
SRET       541    545
START      304    285
STARTR     313    306
STEPIN     96     157
STIMER     357
STPBIT     102    160
STPI       178    181
STPO       183    177  186
STRT       86     673
SUCC       475    468
SWIT       255    249
SXS        522    553
SXT        528
SYNC       76     407
TCTH       22     446  527
TCTL       21     444  525
```

```
TCTP       20
THEEND     766
TJX        84     197
TKIN       155    139  140  178
TKOT       152    141  183
TOUT       85     198  212  292  358
TPXH       44     336  345  466  566
TRKLMT     100    235  753
TRKMSK     99     173  234  423  695
TSSA       55     735
WDTA       77     651
WERR       604    573
WPLS       80     574
WPROT      108
WRTBIT     91     273
WSEX       557    120  528
WSQ        563    558
WSR        564    561
WSS        577    579
WST        582    586
WSU        589    593
WSV        595    599
ZERO       94     309  334  342  347  430  448  513

OPCODE USAGE TABLE
    *    63      ADC  9       AND  15      ASL  12
    BCC  11      BCS  22      BEQ  22      BIT  3
    BMI  1       BNE  31      BPL  4       CLC  12
    CMP  18      CPX  3       CPY  4       DEC  2
    DEX  8       DEY  3       EOR  3       INC  6
    INX  5       INY  3       JMP  15      JSR  43
    LDA  85      LDX  14      LDY  5       LSR  9
    NOP  3       ORA  3       PHA  5       PHP  2
    PLA  7       PLP  5       ROL  7       RTS  28
    SBC  4       SEC  10      SEI  1       STA  59
    STX  3       TAX  3       TAY  4       TYA  1


ADDRESS MODE OCCURENCES
    AY  0        AX  0        ZX  13
    ZY  0        IM  74       IX  0
    IY  3        Z   97       A   27
    NONE  362
```

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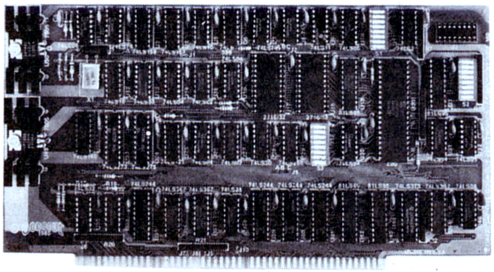

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16K Econoram IX-16	Dig Grp	**$319**	**$379**	n/a
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Circle 104 on inquiry card.

Text continued from page 158:

particles from the head surface. In addition, this operation insures that the head is on the proper track. Another three reads are attempted; if this fails, the data is assumed to be unrecoverable.

The memory locations that must be initialized before a read operation are given in table 4.

The write routines write a contiguous block of memory to the disk on the required number of sequential sectors. They are also responsible for calculating the forward and backward links and the check sum for each sector. Each sector except the last contains 256 bytes of data; if the number of bytes to be saved is not an integer multiple of 256, the last sector may be shorter. Each sector is preceded by 16 bytes of 0s before the sync character. This is followed by the sector header, the data, and the trailer. No read operation is done after writing to verify the data, because the infrequency of write errors does not warrant the extra overhead.

The memory locations that must be initialized before an area of memory can be saved on disk are given in table 5.

Control Routines

The routines SAVK and LODK provide the interface between the user and the disk routines. These routines expect the appropriate information to be preset in memory by use of the KIM keyboard. The only incompatibility with the Percom MINIDOS routines here is in the indication of an omitted value. The Percom routines use the value hexadecimal FFFF to indicate a field not in use, and KIMDOS uses a high-order byte of 0. This is not important since the 6800 and 6502 microprocessors store their high- and low-order address bytes in the opposite order and are not compatible anyway.

The control routines SAVK and LODK convert their parameters into the proper format where necessary and call the disk subroutines. Upon return, these two routines display the results of the requested operation on the KIM display and return control to the KIM monitor. The information displayed is either the DTS number of the last sector read or written in decimal, or FF*nn*, where *nn* is an error code. The error codes are given in table 6.

Interrupts

In any system, it is often desirable to use interrupts for various processes. Because KIMDOS is involved in time-critical functions when doing disk input/output (I/O), an interrupt at the wrong time could cause catastrophic errors. Therefore, the nonmaskable interrupt (NMI) line cannot be used during disk I/O.

However, KIMDOS does allow for the use of the maskable interrupt request (IRQ) line. This is done by saving the status register and disabling the IRQ line before starting any time-critical functions. The status register is then restored after the critical function is completed. This causes the servicing of the IRQ interrupt to be delayed for as much as 20 ms at a time. Any interrupt-driven system that can tolerate this limitation can function properly with KIMDOS.

Testing

Since the drive and controller both come assembled and tested, the checkout procedure is relatively simple. The only equipment I used was a logic probe and a multimeter.

The first step is to connect the drive and controller to the KIM bus and verify all power-supply voltages. When they are correct, basic communication with the controller can be verified by entering the hexadecimal address CC05 via the KIM-1 keypad. This should start the motor and keep it on until the address is changed. If the motor does not start, then there is probably a bad connection to KIM.

Next, the motor-off pulse can be checked by pressing the + key on the KIM keypad to increment the address on the display to hexadecimal CC06. This should turn off the motor immediately. The motor time-out circuit can be checked by entering hexadecimal CC05 on the KIM display,

Hexadecimal Address	Contents
0016, 0017	Beginning memory address (optional; substitute 0 to use address stored in the disk file)
001C, 001D	Drive/Track/Sector (DTS) number of first sector in the file being read

Table 4: *Information required to read a file into memory from disk. The file being read into memory will begin at the address pointed to by hexadecimal memory locations 0016 and 0017. However, if the contents of these two bytes are 0, the file will be loaded into memory beginning at the address stored with the file. The DTS number is stored here in binary-coded decimal format, with the high-order byte stored first.*

Hexadecimal Address	Contents
0008, 0009	Beginning address of memory to be saved
000A	File type
0019, 001A	Execution address (optional ; use 0 to omit)
001C, 001D	Drive/Track/Sector number of first sector to be written
001E, 001F	Ending address of memory to be saved

Table 5: *Information required to save a file. These are the hexadecimal memory locations that must be set before the SAVK (save a file) routine from listing 1 is called. The DTS number is stored here in binary-coded decimal format, with the high-order byte stored first.*

Error Code	Message
0	Disk missing (given after read or write operation)
1	Disk protected (given after write operation only)
2	Invalid sector number (given after read or write operation)
3	Blank sector (given after read operation only)
4	Disk overrun; attempted to write more than 349 sectors
5	Permanent read error

Table 6: *List of disk-related error codes. If a read or write operation ends in failure, the left four digits of the KIM display will read FFnn, where* nn *is one of the error codes listed in this table.*

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18 megabytes (expandable to a 4-drive system). North Star uses a tried-and-proved 14" Century Data Marksman. The interface is through the North Star parallel port and runs with existing software. List $4,999

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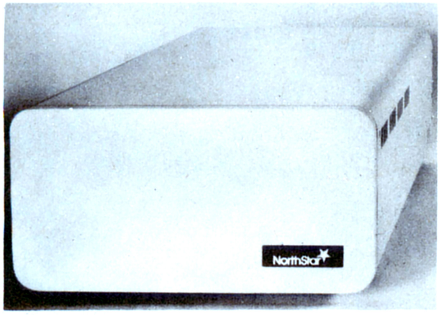

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The Corvus and Lobo interfaces use the new IMI 7710 8" Winchester with 10 megabytes of formatted storage. Either system is available from MiniMicroMart. The Corvus is $5,300 list

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MICROAGE

MicroAge has for some time been marketing hard disk interfaces to the North Star Horizon and to the Alpha Micro System. They have utilized the Konan controller with two popular drives: The Control Data 9448 (PHOENIX) with 32 megabytes of capacity and the Fujitsu M-2201 with 50 megabytes.

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XCOMP KB10

One of the early firms to bring a hard disk to the S-100 bus, it interfaces to the popular, removable cartridge types of disk drive, which have become an industry standard for mini-computers over the past few years. They supply a system utilizing the top-loading 5440-type of cartridge. These drives have been traditionally available with one fixed drive on the bottom with a removable cartridge on top. Some operate at 100 tracks per inch, with a high-density one operating at 200 tracks per inch. The high-density unit allows storage of 5 megabytes per cartridge, or 10 megabytes per drive. The XCOMP controller provides for handling four drives, for a total capability of 40 megabytes. Since the top cartridge is removable, backup is simple, fast, and practical.

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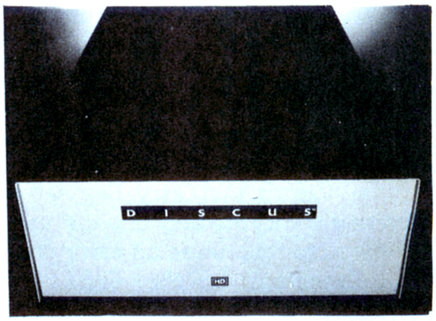

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Hard sectoring means that sector boundaries are detected by means of holes punched in the floppy disk.

followed by another address. The motor should run about 3 seconds and stop.

Now the sector-counting circuitry can be checked. With a disk inserted in the drive, enter hexadecimal CC05 and then hexadecimal CC02. The rightmost digit of the KIM display (which shows the low nybble of the contents of hexadecimal location CC02) should be rapidly changing as long as the motor is running. When the motor stops, this digit should contain a decimal digit (0 thru 9) indicating the last sector passed.

After all of the previously mentioned tests have been completed, the software can be used to do further testing. The TEST routine, given in listing 3, is included for this purpose. TEST does a static test of most of the controller functions and their interaction with various subroutines within KIMDOS. It uses the number of the key pressed on the keypad as an index into a table of subroutine addresses. From there, it does a subroutine jump to the routine thus addressed.

Upon return, the TEST routine displays the value of the accumulator in the rightmost two digits of the KIM display. It also displays the value of the carry flag in the left four digits — FFFF for carry set and 0000 for carry clear. (This is done for those routines that return the carry flag set as an error indicator and use the value in the accumulator as an error code.)

Execution of the TEST routine begins at hexadecimal 0200. The appropriate data must be set in the 0 page for the subroutines to be tested. Some subroutines must be used together. For example, the motor must be started and the drive must be selected before the head-movement routines will work. To add more subroutines, increase the value in the compare instruction at hexadecimal location 020C and add the appropriate addresses to the end of the table.

The final test that I had to do was

Listing 3: *Listing for program TEST. This program executes a given KIMDOS routine (see documentation at the beginning of the listing) depending on which key on the KIM keypad is pressed.*

```
Hexadecimal   Object   Label  Instruction  Operand     Commentary
Address       Code            Mnemonic


                              TEST : ROUTINE TO TEST THE BASIC DISK
                                     DRIVER SUBROUTINES


                              SUBROUTINES UNDER TEST


                        SUB            ADDRESS  KEY#
2000                    GTKX    *      $C022      0    GO TO TRACK 0
2000                    PREP    *      $C00C      1    PREPARE DRIVE FOR I/O
2000                    START   *      $C131      2    START MOTOR
2000                    TKOT    *      $C038      3    MOVE HEAD OUT 1
2000                    TKIN    *      $C040      4    MOVE HEAD IN 1
2000                    SEEX    *      $C060      5    FIND TRACK IN 01
2000                    GTSC    *      $C147      6    FIND SECTOR IN 02
                                                  7    RETURN TO KIM


                              KIM ADDRESSES


2000                    SCND    *      $1F1F
2000                    GETK    *      $1F6A
2000                    KIM     *      $1C4F


                              ZERO PAGE STORAGE


2000                    TOAD    *      $0020
2000                    TODQ    *      $0021
2000                    SAKE    *      $0022
2000                    PNTH    *      $00FB
2000                    PNTL    *      $00FA
2000                    INH     *      $00F9


2000                            ORG    $2000


2000 20 1F 1F           STAR    JSR    SCND     LITE DISPLAY
2003 20 6A 1F                   JSR    GETK     GET KEY
2006 C5 22                      CMPZ   SAKE     DEBOUNCE
2008 F0 F6                      BEQ    STAR
200A 85 22                      STAZ   SAKE
200C C9 08                      CMPIM  $08      VALID?
200E B0 F0                      BCS    STAR     NO
2010 0A                         ASLA            YES, MULTIPLY BY 2
2011 AA                         TAX             TO GET INDEX
2012 BD 32 20                   LDAAX  TABL     MOVE OBJECT ADDRESS
2015 85 20                      STAZ   TOAD     TO JUMP VECTOR
2017 E8                         INX
2018 BD 32 20                   LDAAX  TABL
201B 85 21                      STAZ   TODQ
201D 20 2F 20                   JSR    JMPP     CALL SUBROUTINE
2020 85 F9                      STAZ   INH
2022 A9 FF                      LDAIM  $FF      ERROR FLAG
2024 B0 02                      BCS    STOR     BRANCH ON ERROR
2026 A9 00                      LDAIM  $00      GOOD FLAG
2028 85 FA              STOR    STAZ   PNTL
202A 85 FB                      STAZ   PNTH
202C 4C 00 20                   JMP    STAR
202F 6C 20 00           JMPP    JMI    TOAD

2032 22                 TABL    =      GTKX
2033 C0                         =      GTKX     /
2034 0C                         =      PREP
2035 C0                         =      PREP     /
2036 31                         =      START
2037 C1                         =      START    /
2038 38                         =      TKOT
2039 C0                         =      TKOT     /
203A 40                         =      TKIN
203B C0                         =      TKIN     /
203C 60                         =      SEEX
203D C0                         =      SEEX     /
203E 47                         =      GTSC
203F C1                         =      GTSC     /
2040 4F                         =      KIM
2041 1C                         =      KIM      /



     GETK   1F6A     GTKX   C022     GTSC   C147     INH    00F9
     JMPP   202F     KIM    1C4F     PNTH   00FB     PNTL   00FA
     PREP   C00C     SAKE   0022     SCND   1F1F     SEEX   C060
     STAR   2000     START  C131     STOR   2028     TABL   2032
     TKIN   C040     TKOT   C038     TOAD   0020     TODQ   0021
```

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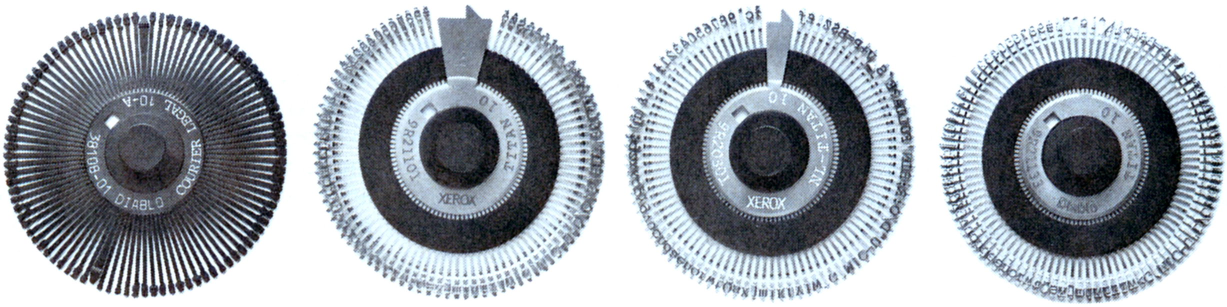

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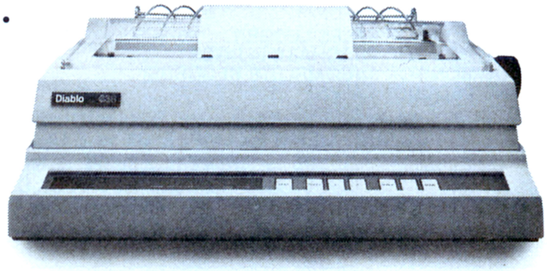

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XEROX

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to read and write data using a floppy disk previously recorded in the Percom format. I did this to confirm that the KIMDOS software produces results using the controller board and disk that are identical to the results produced by the Percom 6800 code. Since I found this to be the case, no one using KIMDOS needs to repeat that test.

Error Recovery

As in all systems, there will occasionally be unrecoverable errors. The Percom format allows for recovery of broken files. Since each sector contains the DTS number of the first sector of the file, each sector can be associated with its file. Reading does not have to start with the first sector; it can start on any sector and will continue to the end of the file.

When a read error occurs, try rereading the sector several times. Also try to read a sector on another track of the disk (to move the head around some) before rereading the original sector in error. Reinserting the disk may also help. If all of the above measures fail, then execute the routine LAST at hexadecimal address C378. This will display the number of the sector containing the error. To try a partial recovery, start the read operation at one sector past the displayed address. If that fails, try the next sector, and so on. Any valid sector can be read in this way. A file may have only one bad sector, with the rest readable.

> Alternating-sector addressing allows time for the housekeeping routines that must be executed between reading and writing sectors.

Expansion

To fully utilize the features of the LFD-400 disk system, a more extensive disk-operating system is necessary. This software is designed to be the basis of such a system. These subroutines can be used to perform the basic functions needed by a larger disk-operating system that provides for named files, automatic space management, and buffered I/O.

To facilitate expansion, KIMDOS has a jump table located at the beginning of the executable code that contains JMP instructions to all subroutines in KIMDOS needed by external software. This allows KIMDOS to be updated (in case of bugs or enhancements) without reassembling the calling routines. With the nine routines in the jump table, any disk I/O can be performed under external program control.

RSEX and WSEX are used to read and write individual sectors. To use them, the data at hexadecimal locations 0000 thru 000A must be supplied. (See the beginning of listing 1.) To read an individual sector, the alternate address pointer, hexadecimal locations 0016 and 0017, must point to the starting location of the file when it is loaded into memory. If the value of the alternate address pointer is 0, the sector will load beginning at an address stored in the sector header. Similarly, to write an individual sector, the data pointer, hexadecimal locations 0014 and 0015, must point to the beginning byte of

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05 = ENTER A/C PAYABLES
06 = ENTER/UPDATE INVENTORY
07 = ENTER/UPDATE ORDERS
08 = ENTER/UPDATE BANKS
09 = EXAMINE/MONITOR SALES LEDGER
10 = EXAMINE/MONITOR PURCHASE LEDGER
11 = EXAMINE/MONITOR (INCOMPLETE RECORDS)
12 = EXAMINE PRODUCT SALES

SELECT FUNCTION BY NUMBER-

13 = PRINT CUSTOMER STATEMENTS
14 = PRINT SUPPLIER STATEMENTS
15 = PRINT AGENT STATEMENTS
16 = PRINT TAX STATEMENTS
17 = PRINT WEEK/MONTH SALES
18 = PRINT WEEK/MONTH PURCHASES
19 = PRINT YEAR AUDIT
20 = PRINT PROFIT/LOSS ACCOUNT
21 = UPDATE END MONTH FILES MAINTENANCE
22 = PRINT CASH FLOW FORECAST
23 = ENTER/UPDATE PAYROLL (NOT YET AVAILABLE)
24 = RETURN TO BASIC

WHICH ONE? (ENTER 1-24)
01 SUB. MENU EXAMPLE: 01 = EXAMINE: 02 = INSERT: 03 = AMEND: 04 = DELETE
05 = PRINT (1,2,3): 06 = NUMERIC COMBINATIONS: 07 = SORT
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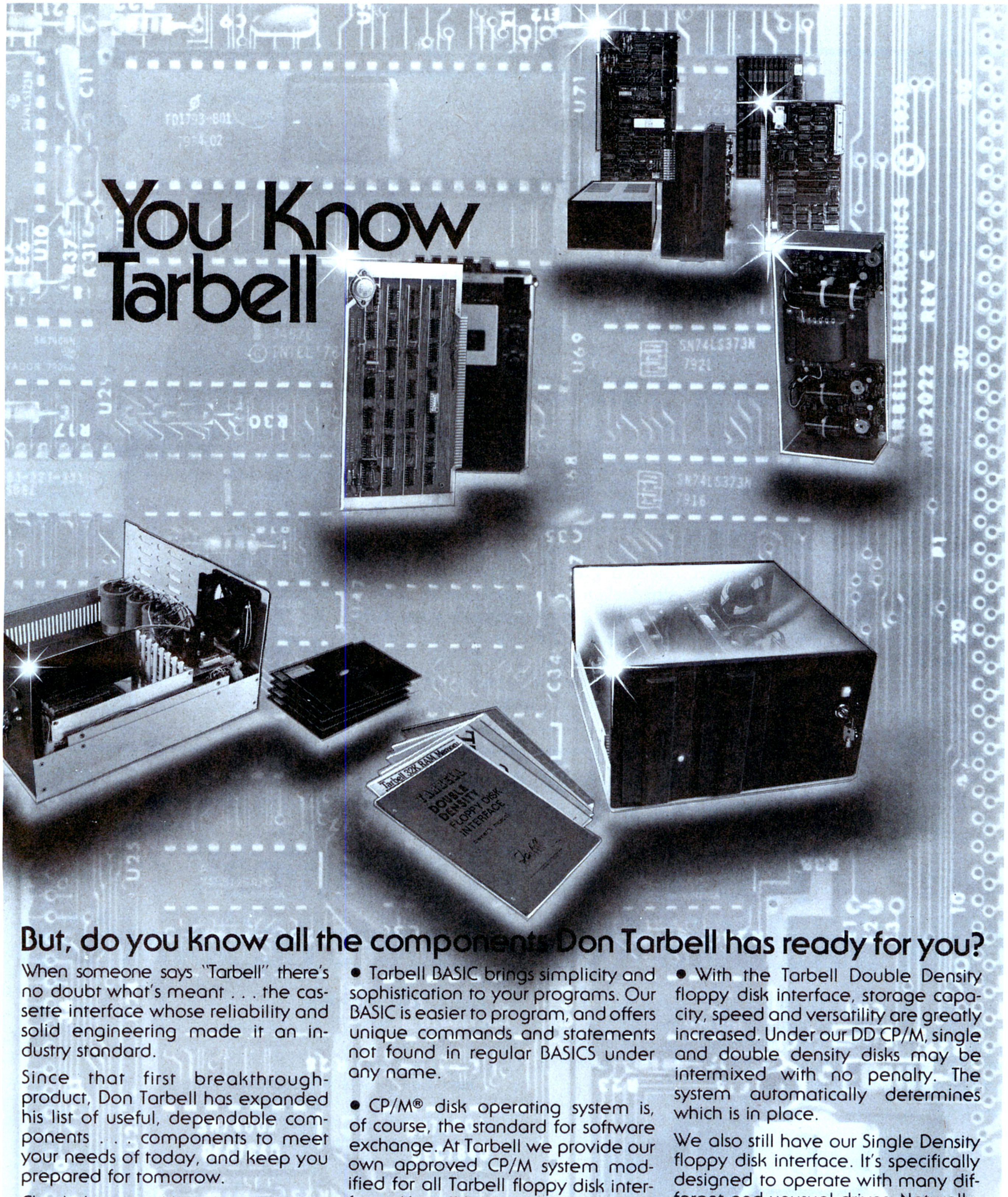

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- Tarbell BASIC brings simplicity and sophistication to your programs. Our BASIC is easier to program, and offers unique commands and statements not found in regular BASICS under any name.
- CP/M® disk operating system is, of course, the standard for software exchange. At Tarbell we provide our own approved CP/M system modified for all Tarbell floppy disk interfaces. Note. We also have MP/M® for those interested in multi user systems.
- The Tarbell VDS line comes as a complete package . . . or, as separate units. For example, the Tarbell mainframe can be ordered with 1 or 2 Shugart or Siemens drives, or no drives. Whichever way you go, you get the reliability of Tarbell tested components.
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Since the drive and controller both come assembled and tested, the checkout procedure is relatively simple.

the area to be stored on the disk file. All head positioning and drive preparation is taken care of.

LODX and SAVX are the subroutine versions of LODK and SAVK. They require the same data as LODK and SAVK, except that the DTS number must be converted to three single-byte quantities and stored in hexadecimal locations 0000 thru 0002. The subroutine PREP can be used to select the desired drive and seek the desired track. The CVTBIN and CVTDEC subroutines convert the DTS number to binary and decimal, respectively. Subroutine FWDC calculates the next sector in a file. The INITDV subroutine sets the track registers to hexadecimal FF. If any errors are encountered, control is returned to the calling routine with the carry bit set and the error code in the accumulator. This allows complete external control of the disk system.

Since developing KIMDOS, I have developed ZAPDOS. ZAPDOS is modeled after Percom's MINIDOS-PLUSX disk-operating system. It allows loading and saving of up to thirty-one named files per disk. It occupies the upper two read-only-memory sockets in the LFD-400 board. ZAPDOS contains thirteen read-only-memory resident commands to manipulate and display disk space and memory. When used with its ten disk-resident utility programs, ZAPDOS transforms KIM into a powerful microcomputer system.

Conclusion

I have been independent of cassette tape for over two years now. It has been a great pleasure to be able to load even the largest file in 1 or 2 seconds. I no longer leave my KIM system on for days to keep from spending the time necessary to write all of memory to tape and verify that the tape is good. The Percom LFD-400 is a viable and cost-effective answer to the mass-storage problem.

KIMDOS should be easily converted for use on other 6502 systems. An interface for the Apple II should be straightforward. KIMDOS is available in a 2708 read-only memory from Percom. (See below.) I would like to express thanks to Bob Haas for his valuable consultation on this project.■

Percom Data Company (211 North Kirby, Garland TX 75042) is making available the current version of KIMDOS on a 2708 erasable programmable read-only memory (EPROM) part to be used on the disk-controller board of the Percom LFD-400 5-inch floppy-disk drive. This can be obtained along with a Percom LFD-400 disk drive for $15 above the current price of the disk-drive unit. A floppy disk containing KIMDOS-related software (including the ZAPDOS disk-operating system mentioned at the end of this article) is also available from Percom.

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LANGUAGES AND TOOLS FOR MICROCOMPUTING: A BYTE CONFERENCE

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June 16-17, 1980
McGraw-Hill World Headquarters
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The microcomputer revolution in system design, engineering, and technology is here!

Sophisticated 32 bit computer architectures are appearing in single packages that may be used in a personal computer, a word processor, or even automobile or microwave oven controls. A typical microcomputer-oriented, finished-product design can incorporate total memory, with an address-space utilization of 16K to 64K bytes. With high-volume manufacturing, the total package may cost as little as $100 to $500.

Over the past 25 years there has been a tremendous evolution in the functional capabilities of language systems. These systems need no longer be confined to "big" machines. Much of the improvement in function is becoming available in language systems for microcomputers.

Yet, major manufacturers are still promoting their "super" micro assemblers/debuggers as the best software tool for applications software of computer systems. Consequently, many programmers and designers continue to work with primitive language tools.

This first BYTE-sponsored conference on languages and tools for microcomputing will introduce designers, systems analysts, implementers, and managers to various high level languages and associated systems tools that are becoming commercially available. Knowledge of these recent developments is absolutely essential to productive use of microcomputer techology when that scarce resource, programmer/designer time, is being spread more and more thinly among a myriad of potential applications.

The conference will zero in on five specific high level languages because they are—or shortly will become—readily available for implementations with small computers. Speakers will explore these languages and tools for programming in terms of their usefulness for practical microcomputer applications.

Three of the featured languages are members of a family of languages evolved from FORTRAN by way of Algol: Pascal, C, and Ada. These are most appropriate for uses in which documentation is as much a part of the design philosophy as the achievement of a functional design itself. HAL/S, also in this family, will be discussed at the conference in terms of the history of software tools used in the NASA space-shuttle project's flight-control system design.These languages share purposes with some of the more common commercial languages available on large computers, such as PL/I and COBOL.

Differing in philosophy and point of view—but also commercially available—are two other languages and corresponding language concepts: LISP and FORTH. Each is characterized by a concept of language extensibility, which is implemented in a highly interactive approach. The central and dominant theme of LISP is one of list structures, which may be either data or program material. The concept of tree structures and relationships underlies LISP's usefulness in the artificial-intelligence milieu. FORTH has a central theme of a stack-oriented processor, emulated as a threaded code interpreter, and an extensible library of operations that may be defined beyond a basis set of standard primitives.

THE PROGRAM

Introduction

Carl T. Helmers, Jr.
Editor-in-Chief
BYTE Magazine

Writing in high level languages has numerous well-publicized advantages: programs are more portable; they have superior structures; they are easier to write and debug. At this first session of the conference, Carl Helmers will survey and define language systems, analyze language systems as complete tools, discuss the evolution of all high level languages, and establish reasons why specific high level languages are appropriate for microcomputers.

The Importance of Tools

Dr. Fred H. Martin
Executive Officer
Intermetrics, Inc.

The use of software tools in the development of systems involving computers is crucially important. Fred Martin, one of the designers of the HAL/S language, will review the advantages of high level language techniques and automated aids to programming from the point of view of his NASA experience with HAL/S, developed specifically to replace the machine-dependent, low-level programming that plagued the Apollo project. The crucial importance of high level languages in reliable software design will be reviewed in the context of this system—in which a software crash can literally lead to a pile of broken parts on the ground.

The Pascal Perspective

Peter Grogono
Analyst/Programmer
Concordia University

The Pascal language is one of the most attractive alternatives in the small computer field. It has steadily gained popularity in use on machines as small as the Apple-II. Peter Grogono, the author of Programming in Pascal, will provide an introduction to the language and discuss its use as a more powerful, more modular, more elegant solution to business data problems.

After Pascal, What?

Dr. Kenneth L. Bowles
Director, Institute for Information Systems
University of California, San Diego

While Pascal is an immensely useful language, it is not necessarily a panacea. Limitations of the language in areas of real time control and handling of multiple concurrent processes, in particular, argue for a new look at the design of the language. Ken Bowles will introduce one evolutionary variant that will become very important over the next decade—the Ada language, originally designed for the Department of Defense. Microcomputer implementations of this language, using machine-independent techniques, will make it a strong alternative for programming microcomputer applications systems.

Trees And Lists as Tools

Dr. Henry G. Baker, Jr.
Assistant Professor
University of Rochester

Not all programming problems are amenable to convenient solutions using conventional block-structured, sequential languages. Many require representing complex heterogeneous objects and relationships among those objects. This approach is attractive for selected applications: symbolic mathematical computation, computer-aided design, commercial integrated databases, English front-end processors, computer-aided manufacturing, robotics control, interactive graphic systems, and interactive integrated circuit-design systems.

The LISP language offers the block-structured control of Pascal, together with the friendly interactive nature of BASIC. In addition, it offers lists and trees as data structuring primitives and a tireless "garbage collector" to keep memory neat and clean.

Henry Baker will discuss the LISP language and the kinds of automated tools required to use it.

What is C?

John A. Morse
Principal Engineer, Corporate Research
Digital Equipment Corporation

The language C was originally developed at Western Electric for use as a tool for development of the UNIX operating system at Bell Laboratories. Now that C compilers are starting to become available for microcomputer systems, this language becomes a viable alternative for both operating system and application developers. John Morse will give an overview of the language C and will detail the types of applications for which it is most appropriate.

The Forth Alternatives

Charles H. Moore
Chairman of the Board
Forth, Inc.

One viable and unconventional approach to programming is the highly interactive language FORTH, a language in which the feature of extensibility is emphasized. The typical implementation of FORTH is a highly integrated combination of software development tools and programming aids oriented toward a conceptual stack machine with integers as the primitive data type. In any given application, unique extensions that fit into the matrix basic core of the language are created by the designer. Charles Moore, the inventor of FORTH, will demonstrate some of the more dynamic uses of the language in real-time applications.

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Who Should Attend

Designers, systems analysts, implementers, and managers with an interest in holding down costs on their software projects. Fields with special applicability include electronics and electronics design, automated manufacturing, scientific instrumentation design, and aerospace control systems.

Tentative Schedule

June 16, 1980

8:00- 9:00 A.M.	**REGISTRATION**
9:00-10:00 A.M.	**INTRODUCTION:** Carl Helmers
10:00-10:30 A.M.	**COFFEE INTERMISSION**
10:30-12:00 P.M.	**THE IMPORTANCE OF TOOLS:** Fred Martin
12:00- 1:30 P.M.	**LUNCHEON**
1:30- 3:00 P.M.	**THE PASCAL PERSPECTIVE:** Peter Grogono
3:00- 3:15 P.M.	**COFFEE INTERMISSION**
3:15- 4:45 P.M.	**AFTER PASCAL, WHAT?:** Ken Bowles
4:45- 5:15 P.M.	**OPEN DISCUSSION**

June 17, 1980

8:30-10:00 A.M.	**TREES AND LISTS AS TOOLS:** Henry Baker
10:00-10:30 A.M.	**COFFEE INTERMISSION**
10:30-12:00 P.M.	**THE FORTH ALTERNATIVE:** Charles Moore
12:00- 1:30 P.M.	**LUNCHEON**
1:30- 3:00 P.M.	**WHAT IS C?:** John Morse
3:00- 4:00 P.M.	**PANEL DISCUSSION:** All speakers

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Programming Quickies

Decisions, Decisions

Geoffrey Gass, 5240 SW Dosch Rd, Portland OR 97201

Frequently, a program has to select one of two positive actions as the result of a test (eg: print a "+" or a "−" after checking the sign of a number).

Conventionally, it might be done in a skip chain like this 6800 code:

```
SGN       TST NUMB       Make the test.
          BMI NEG        One course if negative.
          LDA A #' +     The other course if positive.
          BRA PRINT      Watch out — don't run into NEG.
NEG       LDA A#' –      Minus sign for negative number.
PRINT     JSR OUTPUT     Back together again; print the
                         sign.
```

It's awkward, running into yourself like that. Here is how to avoid the awkwardness and save a couple of bytes:

```
SGN       LDA A #' +     Set up for one course in advance.
          TST NUMB       Then make the test.
          BPL PRINT      Confirming advance choice.
          LDA A #' –     Change course if advance choice
                         wrong.
PRINT     JSR OUTPUT     Print the proper sign.
```

The bytes saved (if not otherwise needed) can be used after the TST NUMB to BEQ (branch on accumulator equal to 0) past the PRINT routine if the number is zero, so 0 will be output without a sign, assuming we are dealing with a 1-byte number.■

Formatted Program Output for the KIM-1

Lawrence A Ezard, PhD, Associate Professor of Engineering, Pennsylvania State University, Capitol Campus, Middletown PA 17057

Here is a short program that might be useful for owners of the MOS Technology KIM-1 system. It can be used to find bugs, and to print out and document programs.

The flowchart in figure 1 illustrates the algorithm utilized. This program will examine the contents of programmable memory and print the program instructions found there. The output is in a format of address, operation code, and operand. The user specifies the starting and stopping addresses to be examined by storing values in the appropriate locations. At the end of its execution, the program returns control to the KIM monitor.

In writing the program, I made use of the fact that, with three exceptions, the least significant digit (in hexa-

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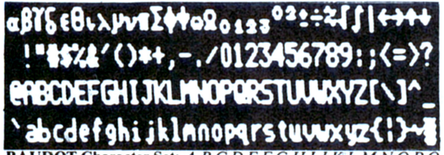
Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



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BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : * 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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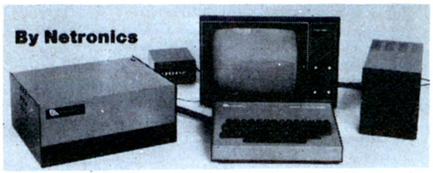
Level "A" at $129.95 is a complete operating system, perfect for beginners, hobbiests, or industrial controller use.

PC Board: glass epoxy, plated through holes with solder mask • **I/O:** provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ...provision for 24-pin DIP socket for hex keyboard/display...cassette tape recorder input...cassette tape recorder output...cassette tape control output...speaker output... LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit I/O ports • **Crystal Frequency:** 6.144 MHz • **Control Switches:** reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • **Counter/Timer:** programmable, 14-bit binary • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000 leaving 0000 free for user RAM/ROM. Features include tape load with labeling ...tape dump with labeling...examine/change contents of memory ...insert data...warm start...examine and change all registers...single step with register display at each break point, a debugging/training feature...go to execution address... move blocks of memory from one location to another...fill blocks of memory with a constant...display blocks of memory ...automatic baud rate selection...variable display line length control (1-255 characters/line)...channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling... tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all registers...single step with register display at each break point ...go to execution address. Level "A" in the *Hex Version* makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.



Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys. 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

Level"B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks...address decoding for onboard 8k EPROM expansion selectable in 8k blocks...address and data bus drivers for onboard expansion...wait state generator (jumper selectable), to allow the use of slower memories...two separate 5 volt regulators.

Explorer/85 with Level "C" card cage.

Level "C" Specifications

Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and cards are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

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Listing 1 continued:

```
03A4  20  3B  1E         JSR  PRTBYT   Print Op Code
03A7  20  9E  1E         JSR  OUTSP    Space
03AA  20  9E  1E         JSR  OUTSP
03AD  20  63  1F         JSR  INCPT    Increment address
03B0  A2  00             LDX  #$00     Load contents of
03B2  A1  FA             LDA  (FA,X)   address at FBFA
03B4  20  3B  1E         JSR  PRTBYT   Print Operand
03B7  20  63  1F  INCAD  JSR  INCPT    Increment to next Op Code
03BA  A5  FB             LDA  FB       Address
03BC  CD  F8  17         CMP  EAH
03BF  F0  03             BEQ  NEXT
03C1  4C  0B  03         JMP  START1   If this address is
03C4  A5  FA      NEXT   LDA  FA       equal to the ending
03C6  CD  F7  17         CMP  EAL      address then stop
03C9  F0  03             BEQ  STOP     Otherwise go to START1
03CB  4C  0B  03         JMP  START1   and print the Op Code
03CE  4C  4F  1C  STOP   JMP  START
```

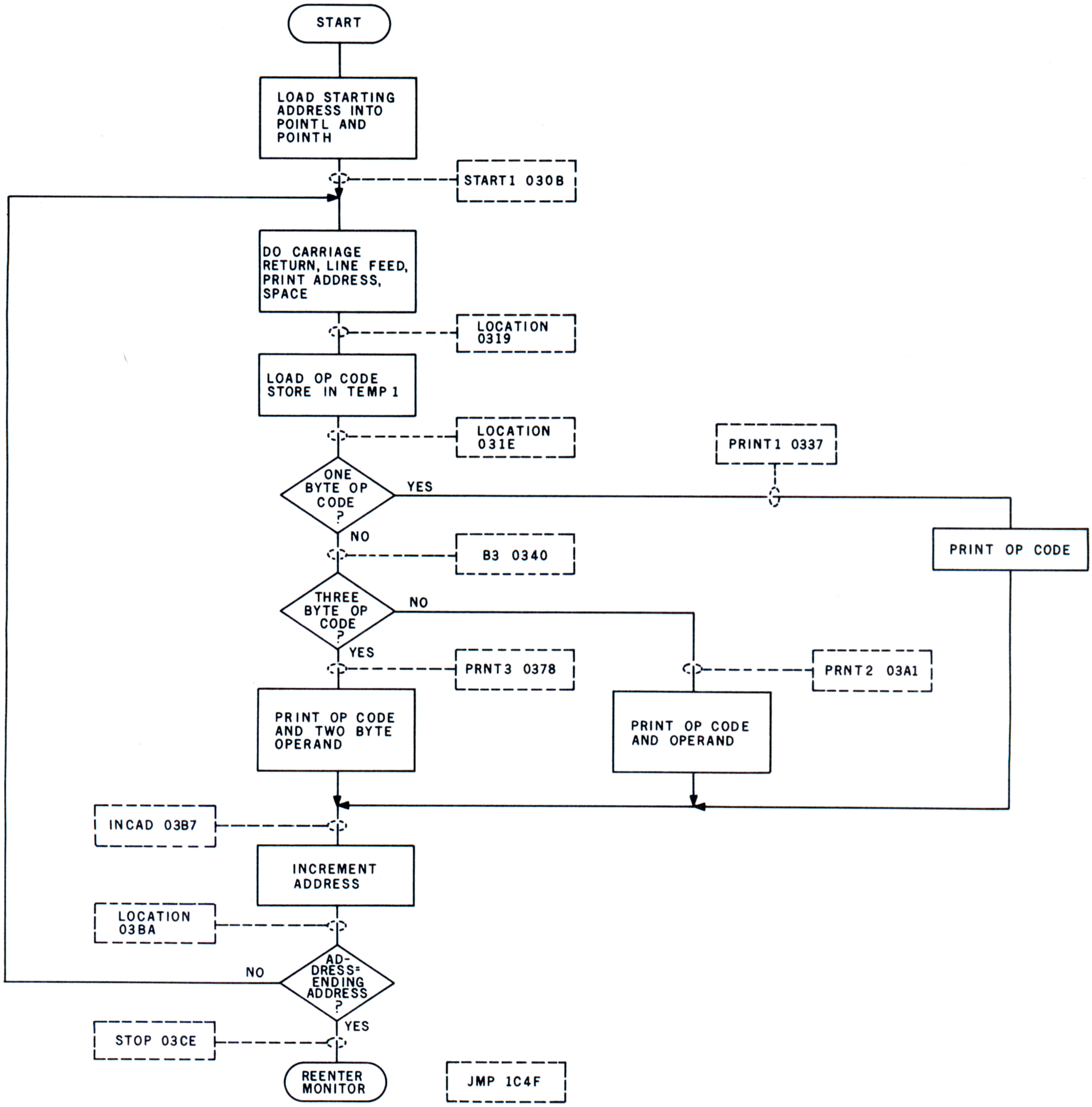
START
LOAD STARTING ADDRESS INTO POINTL AND POINTH
START1 030B
DO CARRIAGE RETURN, LINE FEED, PRINT ADDRESS, SPACE
LOCATION 0319
LOAD OP CODE STORE IN TEMP 1
LOCATION 031E
PRINT1 0337
ONE BYTE OP CODE ?
YES
NO
PRINT OP CODE
B3 0340
THREE BYTE OP CODE ?
NO
YES
PRNT3 0378
PRNT2 03A1
PRINT OP CODE AND TWO BYTE OPERAND
PRINT OP CODE AND OPERAND
INCAD 03B7
INCREMENT ADDRESS
LOCATION 03BA
NO
AD-DRESS= ENDING ADDRESS ?
YES
STOP 03CE
REENTER MONITOR
JMP 1C4F

Figure 1: *Flowchart of procedure used to print hexadecimal instruction codes from KIM-1 memory.*

Until now, computer graphics suffered from terminal high cost.

If you've ever considered displaying Tektronix* graphics data from a host computer, you know all about terminal high cost. A hunk of hardware like a Tektronix 4010 graphics terminal can set you back quite a few kilobucks. It's enough to drive a person of modest means to the drafting table.

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ABW Corporation has just made graphics display as practical as the personal computer. With TEKSIM. The Apple II/Tektronix 4010 Simulator. TEKSIM is a read-only memory (ROM) that plugs directly into an inexpensive Apple II* computer. Combining an advanced programming technique known as *distributed processing* with Apple's high resolution plotting capabilities enables TEKSIM to emulate Tektronix 4010-series terminals at a fraction of the cost. (A symbolic representation of TEKSIM in operation is provided below for the technically minded.)

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The TEKSIM-Apple combination functions in the same way as a Tektronix terminal, displaying graphical output from a host computer *without any modification to the host-resident program.* You can also input data to the host using game paddles or a joystick. And a TEKSIM-Apple terminal even has features not available in the 4010-series. Six-color "palette" for multicolored displays. Selective erase. Video output to allow any size television to serve as the screen. Plus the added benefits of a powerful Apple II computer to use both in and out of graphics mode. Any compromise? Just one. Apple's resolution is about a fourth that of a Tektronix terminal. Still more than adequate for most applications.

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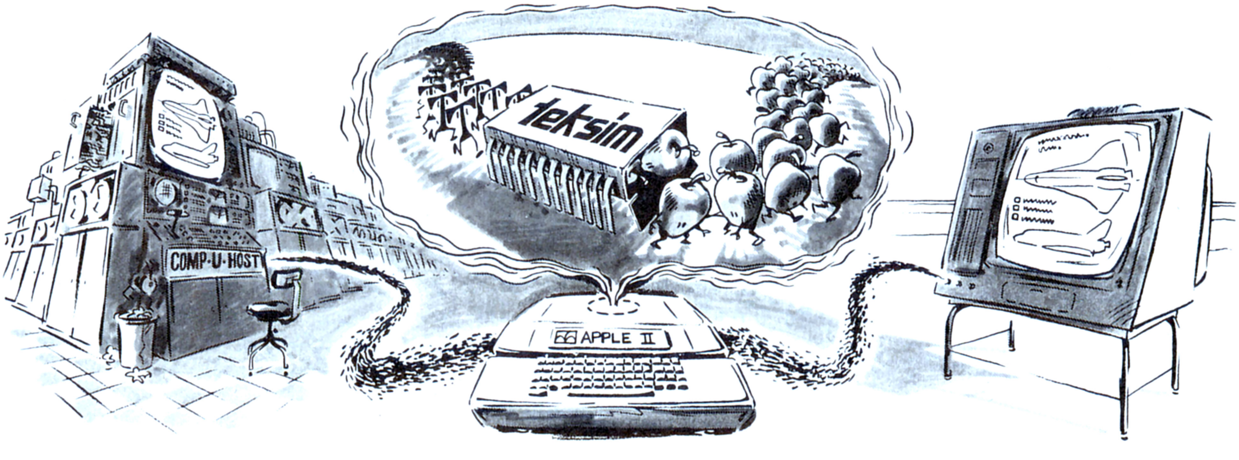

Here's how TEKSIM works: First, Tektronix data comes out of the host computer.

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Munnecke	M520
Minnecke	M520
Munnuke	M520
Munneake	M520
Munneeke	M520
Municky	M520
Muneeck	M520
Monkey	M520
Muneick	M520
Munnick	M520
Monnecks	M521
Muuncake	M522
Munnedie	M530
Lunnecke	L520
Munnecle	M524
Euler	E460
Gauss	G200
Hilbert	H416
Knuth	K530
Lloyd	L300
Lukasiewicz	L222
Smith	S530
Smyth	S530
Smythe	S530
Smitty	S530
Gonzales	G524
Gonzalez	G524

Table 1: *Sample Soundex code for several names. The first fourteen names following the author's are misspellings of his name, actually found on mail, along with their respective Soundex codes. Notice that most of the misspellings reduce to the same Soundex code and could identify the correct name.*

There is a technique which has been used since the turn of the twentieth century to retrieve names based on pronunciation, rather than their spelling. It is called the Soundex code, and was originally developed to search for names in the 1890 census files. The technique is to give each name a four-character code, consisting of the first letter of the last name followed by three digits representing the sounds found in the rest of the name. This code is then used to group together all names which "sound like" each other.

The Soundex code allows the user to enter a name in a form believed to be the proper spelling. The computer responds with a menu listing all sound-alike names, allowing the user to make a selection. If only one name is found, the computer could confirm the name identity and proceed.

Letters	Code Digit
b,f,p,v	1
c,g,j,k,s,x,z	2
d,t	3
l	4
m,n	5
r	6

Table 2: *Numeric single-digit codes that are assigned to letters from the corresponding groups as they occur in a name being encoded in the Soundex system.*

For example the user could misspell "Gonzales" as "Gonzalez"; "Smythe" as "Smith"; or "Andersen" as "Anderson." I am particularly sensitive to this problem because my name (loosely pronounced "money-key") is regularly misspelled. Table 1 shows a sample of the misspellings, as collected from actual mail I have received during the last two years.

The exact use of the Soundex code varies greatly with the computer's file-management system. Some database management systems support Soundex codes directly; others require the programmer to structure the search logic. The program is easily modified to arrange sounds in groups other than as shown. Therefore, there are many modified versions of this technique in use around the country to account for local variations in names and programmer's whims.

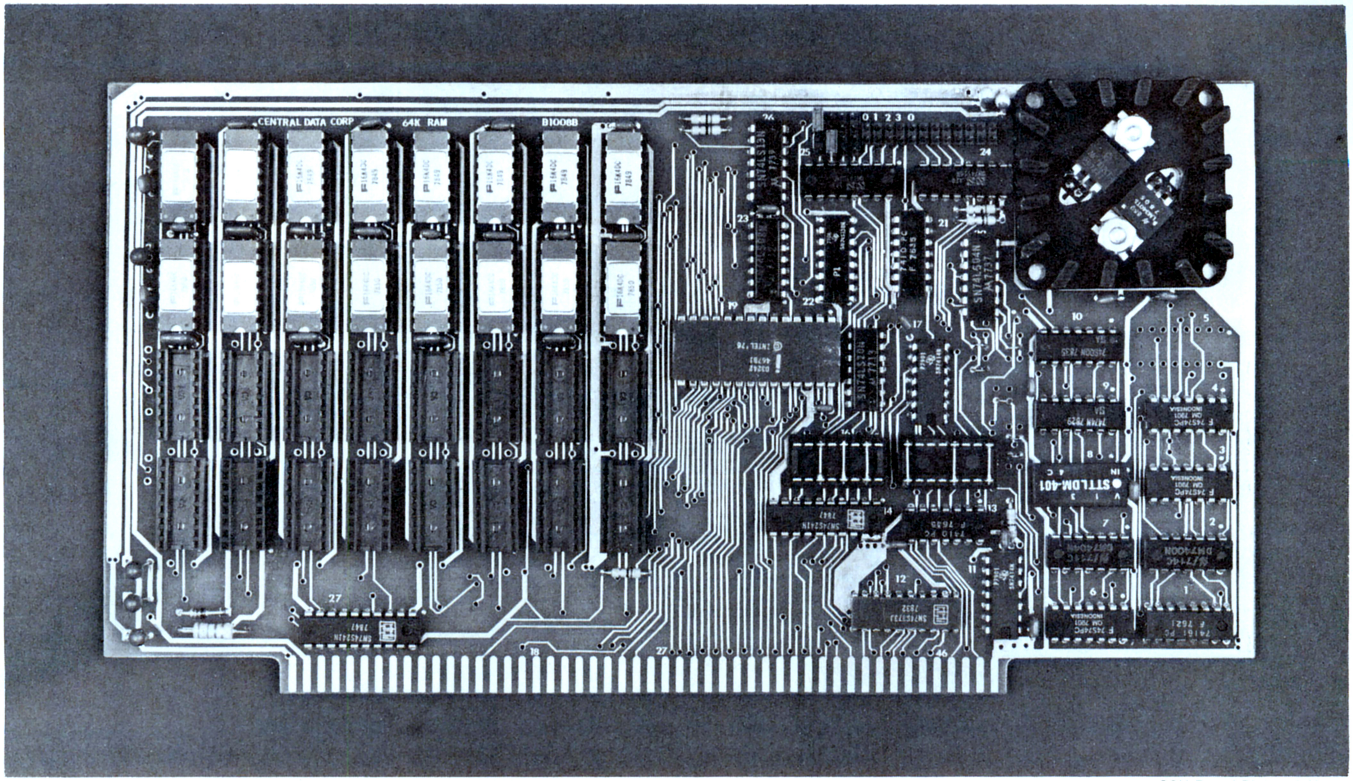
The user might see the Soundex routine working as follows (user input is italicized):

```
WHAT NAME: SMITH
SELECT ONE:
1. Smith, Jack        123 Main St
2. Smith, John        456 Central St
3. Smythe, Zachary 789 First Ave
Enter Choice:__________
```

If there is only one name with the sound, the computer might respond:

```
WHAT NAME: SMITH
John Smith, 123 Main St
```

This approach is only the most simple technique. It can be enhanced by adding the first initial of the first name, sex, birthdate, or other characteristic



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Listing 1: *Soundex program written in Microsoft BASIC for the Commodore PET. Table 3 describes variables used in the program.*

```
100     REM TEST DRIVER FOR SOUNDEX
110     INPUT "LAST NAME";N$
120     GOSUB 2000:REM EXECUTE SUBROUTINE
130     PRINT "SOUNDEX CODE =";S$
140     GOTO 100
2000    REM SOUNDEX ROUTINE TOM MUNNECKE 2/22/79
2010    REM RETURNS SOUNDEX CODE S$ FROM LAST NAME N$
2020    REM SEE KNUTH, "ART OF COMPUTER PROGRAMMING", VOL #3, P 391
2030    REM L$="   ": REM LAST SOUND
2040    S$=MID$(N$,1,1):REM START WITH FIRST LETTER OF NAME
2050    IF LEN(N$) < 2 THEN 2200:REM SKIP SHORT NAMES
2060    FOR I = 2 TO LEN (N$):REM FOR EACH REMAINING LETTER
2070    E$=MID$(N$,I,1):REM SELECT I-TH LETTER
2080    E=ASC(E$)-64:REM CONVERT A THRU Z TO NUMBER 1 THRU 26
2090    IF E > 26 OR E < 1 THEN 2160:REM USE ONLY LETTERS
2095    REM SELECT SOUNDEX CODE
2100    K$=MID$("0 1 2 3 0 1 2 0 0 2 2 4 5 5 0 1 2 6 2 3 0 1 0 2 0 2",E,1)
2110    REM         A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
2120    IF K$=L$ OR K$="0" THEN 2160:REM SKIP TWO CONTIGUOUS SOUND-ALIKES
2140    S$=S$+K$:REM BUILD UP SOUNDEX RESULT
2150    IF LEN(S$)> 3 THEN 2200:REM ONLY FIRST 4 SOUNDS
2160    L$=K$:REM SAVE LAST SOUND
2170    NEXT:REM DO NEXT CHARACTER IN NAME
2200    S$=LEFT$(S$+"000",4):REM PAD TO RIGHT WITH ZEROS AND SHORTEN TO 4 CHARS
2210    RETURN
2999    END
```

to identify the person with greater accuracy.

Constructing the Soundex Code

The technique for constructing the Soundex code is found on page 391 of *The Art of Computer Programming, Volume 3: Sorting and Searching* by Donald Knuth (published by Addison-Wesley, Reading MA). The four steps in generating a Soundex code are:

1. Retain the first letter of the name, and drop all occurrences of a,e,i,o,u,w,y,h and q in other positions.
2. Assign *group numbers* to the remaining letters after the first according to the scheme given in table 2.
3. If two or more letters with the same code are adjacent in the original form of the name

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Basic In A Nutshell

Name: Step-By-Step
Vendor: Program Design, Inc., 11 Idar Court, Greenwich CT 06830
Price: $49.95
Purpose: Teaches how to program a TRS-80 using BASIC
Documentation: Outstanding
Loading: OK – Level 6, not critical
Implementation: This is a case of a BASIC program that teaches BASIC programming. It starts out with the assumption that the student only knows how to turn the TRS-80 on. Three cassette tapes are mounted in the cover of a loose-leaf notebook that also contains supplementary information frames. The course is divided into ten two-part lessons. From a simple PRINT "HI" through arrays and graphics to complex programs, all of the Level II commands and statements are exercised.

The instruction method consists of explanation, example, trial and testing. Commands and statements are presented and explained, examples are shown both on the screen and in the notebook, and then the student is presented with some problems to solve using the BASIC elements under discussion. If an incorrect answer is given, two more tries are allowed, and then the correct answer is displayed. Each lesson ends with a test that is administered and scored by the computer. The results are then entered into the student's progress chart. More comprehensive examinations are given at the end of Lesson 5 and at the end of the course.

Suitability: This is the kind of educational programming that personal computing needs more of. The student (my teenage son) learned much more quickly than I could have taught him, and at his own pace. However, this course isn't just for youngsters but for anyone who wants to be able to program effectively using the BASIC language. In a household where there isn't anyone to do the teaching, this course would be especially useful. I'd like to see a similar course for assembly-language programming.

Other software available from the same vendor: IQ Builders (four different kinds), Memory Builder and Story Builder.

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80 Microcomputing, February 1980

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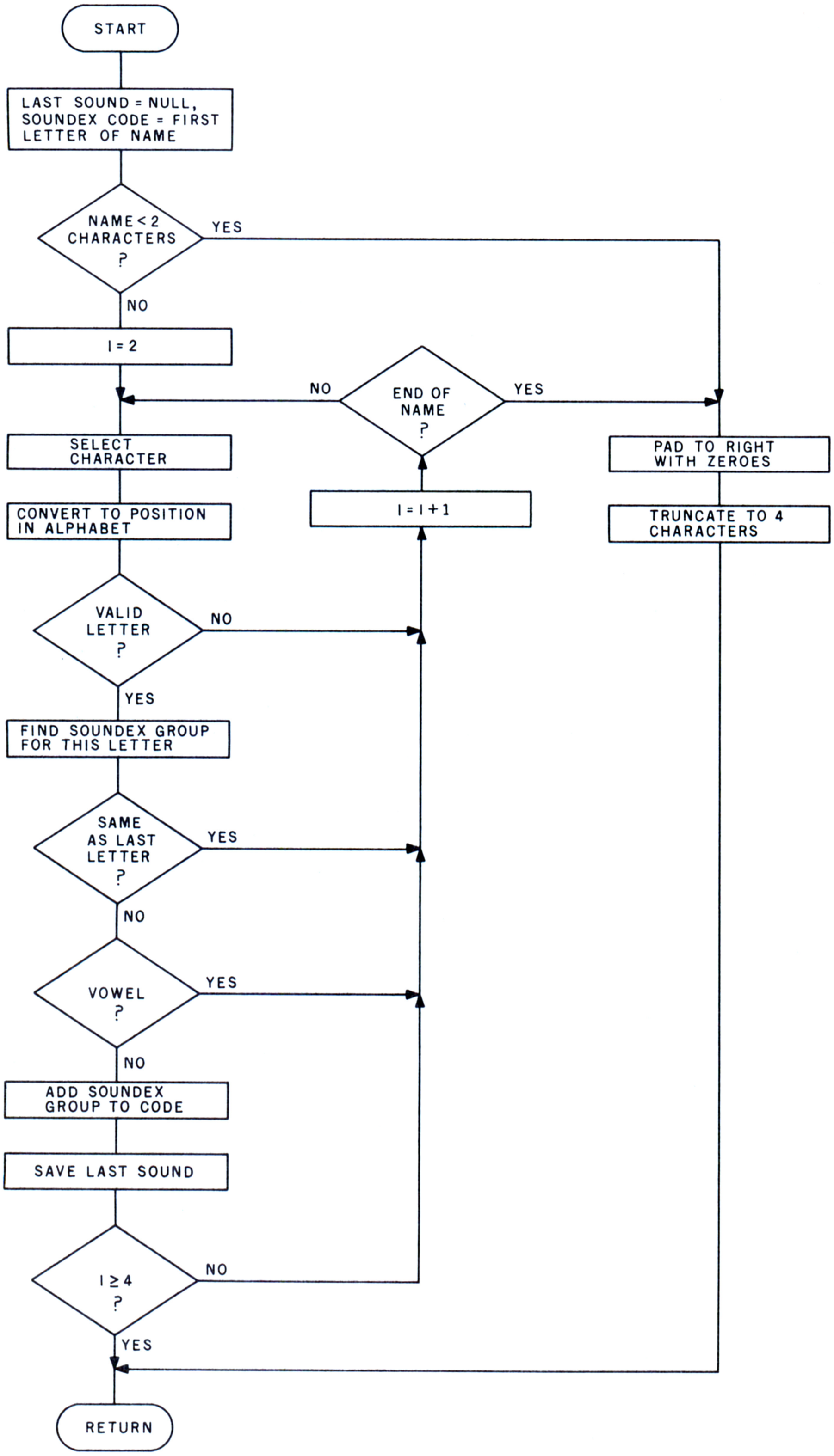

START
LAST SOUND = NULL, SOUNDEX CODE = FIRST LETTER OF NAME
NAME < 2 CHARACTERS ?
YES
NO
I = 2
NO
END OF NAME ?
YES
SELECT CHARACTER
PAD TO RIGHT WITH ZEROES
CONVERT TO POSITION IN ALPHABET
I = I + 1
TRUNCATE TO 4 CHARACTERS
VALID LETTER ?
NO
YES
FIND SOUNDEX GROUP FOR THIS LETTER
SAME AS LAST LETTER ?
YES
NO
VOWEL ?
YES
NO
ADD SOUNDEX GROUP TO CODE
SAVE LAST SOUND
I ≥ 4 ?
NO
YES
RETURN

Figure 1: *Flowchart of the Soundex algorithm subroutine.*

Input
N$ — Name to be coded

Output
S$ — Soundex code of N$ (form: letter,digit,digit,digit)

Temporary
I — Character position in N$ under consideration
E$ — Ith Character in N$
E — Alphabetic sequence of E$
L$ — Last sound during evaluation

Table 3: *Variables used in the Soundex program.*

(before step 1), omit all but the first.

4. Convert the name to the form *letter, digit, digit, digit* by adding trailing zeroes (if there are less than three digits), or by dropping rightmost digits, if there are more than three.

BASIC Program

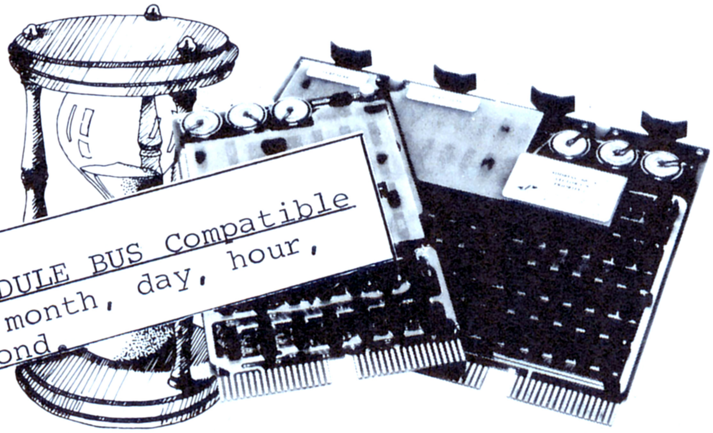
Listing 1 shows the Soundex code generating subprogram that constructs the encoded form from a last name. It was written and tested on a Commodore PET 2001 computer, but it should work on any computer using Microsoft BASIC. It should work on other BASICs which have LEFT$, RIGHT$, and MID$ functions, and use "+" for string concatenation.

Figure 1 shows the flowchart describing the program's operation. Line numbers on the flowchart correspond to the BASIC line numbers in listing 1. The program is separated into two parts: the Soundex routine, starting at line 2000, and a test driver starting at line 100. The driver is used to ask for a name, invoke the Soundex generator, then print the results. It will be replaced by your program logic for filing and retrieving. The Soundex generator in line 2000 accepts as input the variable N$, representing the last name to be converted. It returns S$, the Soundex code for N$.

The only tricky part of the program is contained between lines 2080 and 2110. Instead of testing each letter individually, as shown in the original technique above, the program converts the letter to a number from 1 to 26, representing its position in the alphabet. It then uses this number to index a character string, containing the group codes for each letter. The comment below the index line at line 2110 documents this technique, and provides a reference in case the codes need to be changed.

The Soundex subroutine may be incorporated into programs that require the computer to understand user input. The addition of a Soundex routine can increase the usefulness of a computer. ■

TIME after TIME



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The Club Computer Network

Joe Kasser
11532 Stewart Ln
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Does a club need a computer network? What are its uses? What are the advantages of having such a network?

This article attempts to answer these questions and provide ideas on the techniques used in implementing the network.

Basic Communications Needs

An important aspect of any hobby is communication. The sharing of information and experiences can add a great deal of enjoyment and save much time. If the techniques used to solve some problem are made available by the solvers to others, the recipients of the solution can advance the state of the art. This is done by building upon the foundations developed by the original solvers, rather than by rebuilding the same foundations.

In the computer field, communications fall into two similar but distinct categories: the exchange of personal messages and the exchange of computer data (programs or data bases).

Personal messages may contain any plain language text. Computer data may contain programs, data bases, and instructions for processing files.

Computer data comes in many forms. In the personal computer area, data may be on paper tape, cassette tape, or floppy disk. If it is on cassette, it may be in a digital saturation format or some modulated audio format. It may also be recorded at one of several data rates.

If data is on a floppy disk, the disk may be soft-sectored or hard-sectored. Data may be on 5- or 8-inch disks, which may be single or double density, single or double sided. The disk format may be compatible to a disk operating system such as CP/M or North Star, or it may not.

Most computer users do not have the means for reading or writing all of the different types of off-line storage media. Thus, two users who wish to share software may have what is known as a "media incompatibility problem."

A typical example occurs in the Chesapeake Microcomputer Club (CMC). Two members own 8080 or Z80-based systems, each running the Digital Research CP/M disk operating system. One member, however, uses 8-inch soft-sectored disks, while the other uses a North Star system (5-inch hard-sectored disks). They have no compatible medium such as tape. How then are they to share computer files?

The club is spread out over a wide geographic area. Several of the officers require access to the club roster or membership list. Currently the list is kept by one officer who has to update it, see that labels are printed for mailings, and send physical copies of the list to the other officers. Since officers may live 30 to 50 miles apart, the telephone and postal services are the only practical method for information exchange. There must be a better way.

The club has a need for disseminating information. Reports concerning main meetings, chapter meetings, group purchases, surplus information, and special interest groups have to be made available to the membership. Currently the information is passed out at meetings and through the mails by a monthly newsletter. Is there a better way?

Many of the members possess their own computer systems. The degree of sophistication ranges from a simple KIM-1 to a system with dual disk drive, large amounts of memory, and line printers. A number of members have become involved with the club computer project and the group-purchase plan for equipment. Each one of these systems is in a different stage of development. Many people are finding that their system cannot perform the tasks that they wish it to perform, because several system components (such as extra memory or disk storage capability) are lacking for one reason or another. Perhaps the capital outlay involved is not available, or they are waiting for deliveries to take place.

When contemplating the purchase of additional hardware and software, decisions involving hundreds of dollars must be made, sometimes with little factual information. At club meetings members can discuss their requirements and experiences, but that just results in acquisition of information about how a particular item of computerware works in someone else's environment and how it meets *his* requirements.

It would be nice to be able to get together with a friend and gain hands-on experience of the way that a computer system component performs in one's own environment before purchasing it. Visiting friends

---

About the Author

Joe Kasser is vice-president of the Chesapeake Microcomputer Club, director of information and publicity of the Radio Amateur Satellite Corp (AMSAT), and editor of ORBIT. He has worked with microcomputers professionally since 1975, and has built an 8080-based, S-100 computer system which served as the prototype for the club's construction project. He has contributed other articles to BYTE, including "AMSAT 8080 Standard Debug Monitor" (September 1976, page 108, with Richard C Allen), "The Sky's the Limit" (November 1978, page 48) and "The AMSAT-GOLEM-80" (September 1979, page 182).

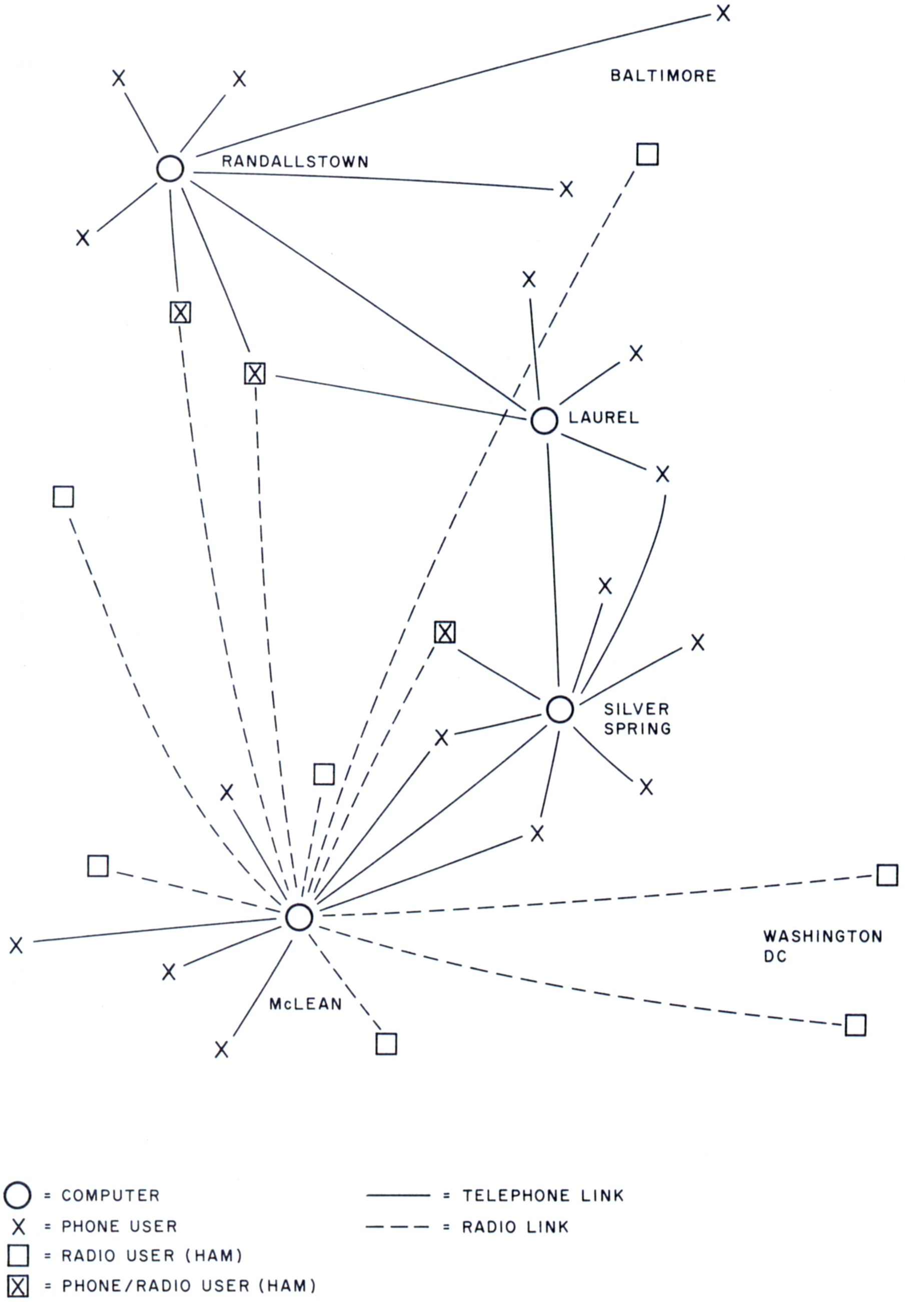


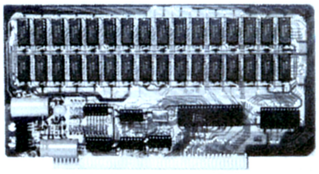
Figure 1: *Diagram of sample telephone and radio-data transmission links in a typical club computer network. Several computers form nodes in the network. Solid lines indicate telephone links; dotted lines indicate links through a 2-meter band amateur radio repeater system (at the same location as one of the computers). Communities identified are located in northern Virginia and in Maryland (except for Washington DC).*

and using their systems can provide this facility, but it is inconvenient, especially when a long session is planned or the traveling distance is great. There must be a better way.

Basic Network

There *is* a better way. It is called *a club computer network*. All club members can have access to it. It may be centralized or distributed, but it will provide a service to the club members. Access may be via the telephone line or via amateur radio-teletypewriter (RTTY) circuits. Each access method has its own advantages and disadvantages.

An example of such a network is shown in figure 1. It incorporates both radio and telephone links. It also allows for a number of computers in the system. It is spread out over a



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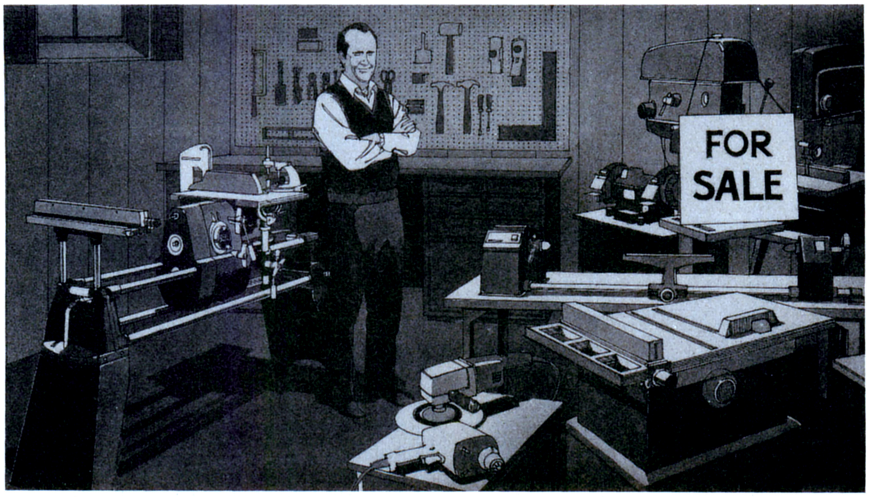

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relatively wide geographic area. One computer may be accessed either via a 2-meter FM radio-teletypewriter repeater (operated by the Amateur Radio Development Association, AMRAD, using the frequencies 147.81 and 147.21 MHz), or via the telephone line. The other computers are operated on behalf of the Chesapeake Microcomputer Club Inc by various members. Note that this area-wide operation is necessitated by the geographic dispersal of the membership of the two clubs.

The central computers are located so that at least one computer is within local telephone-dialing range of each club member. Several members may be within local dialing range of more than one. If one machine in the network is down, or in use at any particular time, these members can try to access another computer.

The radio link can be used by virtually any amateur radio teleprinter station in the area that is equipped for 2-meter FM operation. Of course, *any* member of the club can access any computer by making a long-distance telephone call.

Data is collected in each computer for remote retrieval at a later time. If the data in one machine is addressed to a user outside the local telephone area, the data is automatically sent to the computer in the distant area in the late evening, when long-distance telephone rates are lowest. This inter-computer transfer takes place once per night per machine in a predetermined sequence to transfer the maximum number of messages with the minimum number of calls.

Link Types

Consider first the characteristics of the radio links. Many amateur radio operators already use noncomputerized automatic-starting radio-teletypewriter equipment for receiving message traffic. A computer network for message handling is a logical successor to these existing autostart networks.

The existing noncomputerized network works as follows. All stations monitor the same frequency. Messages are sent blind; when a message is originated into the network, the sender does not know for certain if the destination station is

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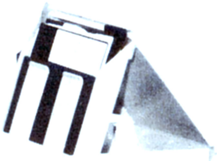

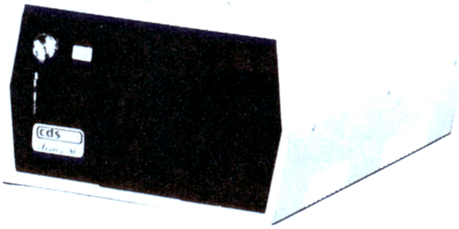

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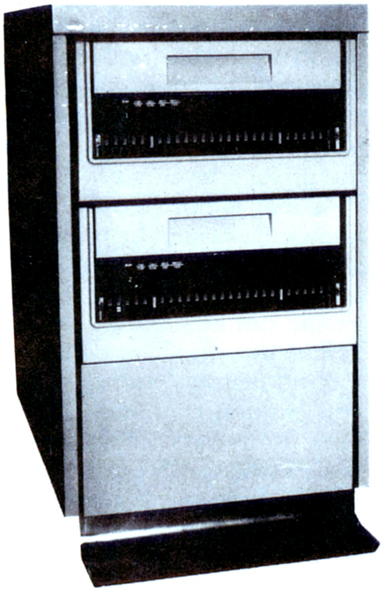

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monitoring the frequency, unless 2-way contact is first established. In the evening, or during weekends, this may not pose much of a problem, because the probability of someone being at home is great. However, during the working day, that probability decreases. Thus, if contact cannot be established directly, the message can still be *sent*, but there is a probability that the destination receiver will not be on line, and the message will be lost.

If, however, the message can be stored in a central computer by the sender, and retrieved later by the receiver, the probability of successful transmission of the message from sender to receiver is almost certain. The addition of a computer therefore becomes an asset to the network.

If several stations in the network have computers capable of answering back to the sender, the utilization of the computer may be reduced. A sender can put out a direct call. If an answer is not received (indicating that the destination is not on line or monitoring at the time), the message can either be transmitted to the computer for storage, or held and transmission attempted again at a later time. It is also possible for the assignment of which network computer will perform the store and forward operation to be rotated among the various member-station computers on basis of availability, as long as the network computer has a distinctive identification.

With a radio network set up in this way, anyone equipped either with simple radio-teleprinter equipment or with sophisticated computer equipment may make use of the full network message storage and forwarding capabilities. This concept of allowing minimally equipped stations to access the network requires that simple techniques be used for data transfer. These include 5-level ("Baudot") or ASCII plain language text, a control language that is readable by both man and machine, with minimal error checking. The advantages of more sophisticated techniques mean that many people will want to use them. That leads to a hierarchical concept of the network utilization. This will be discussed later.

The disadvantage of the radio network is that since everyone is on line, the privacy level is zero. Therefore, data that is not intended for public knowledge cannot be passed over the network. For this reason, mailing lists and other confidential club data should not be passed over the radio link. *[Also, FCC regulations require that* no *message traffic pertaining to any business or commercial activity may be transmitted by an amateur radio station...***RSS***]*

Use of the telephone line for gaining access to the computer limits the number of users that can be on line at the same time. One great advantage of the telephone line is security. The connection between the user and the computer is private. Mailing lists can be accessed and changed remotely without compromising the security of the data, provided that only authorized users are allowed access to these data files.

System Implementation

Bringing up the network for the first time can be simple or complex. One method is to install a computer equipped with dual floppy-disk drives, 32 K bytes of memory, and the phone line, and make it available 24 hours per day. It is an expensive method, especially when the demand

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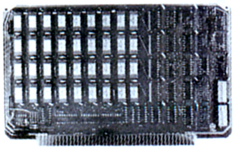
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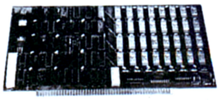
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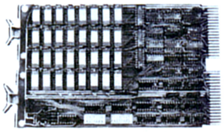
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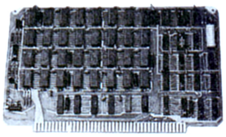
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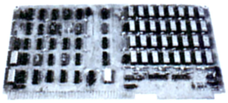
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for such a service has not yet been demonstrated in the club.

A second method is to bring the service on line gradually, using equipment belonging to club members, and then put together a club system as club finances allow. This method has the advantage that the cost can be spread out over a period of time, but does have a disadvantage because there will be many intervals during the early stages of the network implementation when the system is not available.

The network can be started by one or more club members making their personal systems available. On the radio link, there will be no noticeable difference with the different computers, since they should all answer to the same call sign, and the user need not know which machine is storing his traffic. In practice each computer will also transmit its own station call sign as required by law.

Telephone access is a little more difficult, because a list of numbers must be made available to the network members, and a rule must be established for dialing the computer. An example of such a rule is that if the computer does not answer by the second ring, dial another number.

When the system is first put into use, it will be lightly loaded. It can thus be used for secondary purposes apart from the message storage or media transfer applications. Club members will have a chance to use the sophisticated system and to play with it. The availability of any single computer during the early stages may be intermittent: since it is the personal system of a club member, it will be available for club use only when the owner is not using it. This unreliable accessibility will encourage members to upgrade their systems as fast as possible for their noncommunication uses. However, the system as a whole will have a greater reliability, since there is a good probability that at least one computer will be available when one is required.

Using the Telephone Link

The typical telephone communication system operates at a data rate of either 110 or 300 bits per second (bps), allowing the use of simple Bell 103-compatible modems. In order to set the data rate for a transmission, each user must transmit a carriage

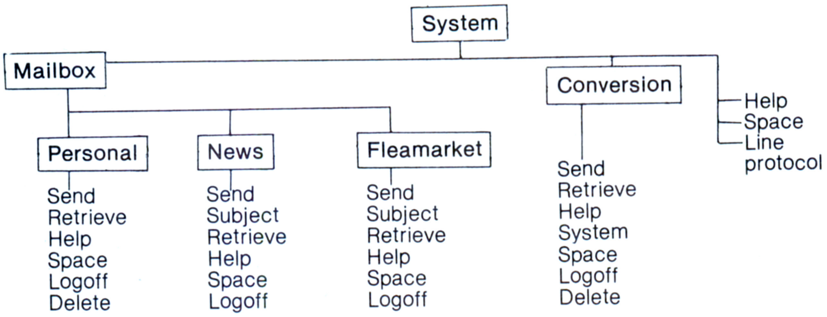

Figure 2: *Hierarchy of software modes in the club computer network software. Names of program routines are enclosed in boxes. Commands available with each program are listed below.*

A Message to our Subscribers

From time to time we make the BYTE subscriber list available to other companies who wish to send our subscribers promotional material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services, or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

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Due to a miscommunication between our advertising agency and BYTE Magazine, an advertisement for North Star Computer new Applications Software ran in April instead of May. This ad was not intended to appear until all North Star dealers had been informed of our new software products and were prepared to handle customer inquiries.

We regret any inconveniences and embarrassment this has caused North Star dealers and customers, and we are grateful to BYTE for allowing us to clarify this situation. The new Application Software packages will be available through North Star dealers in early May.

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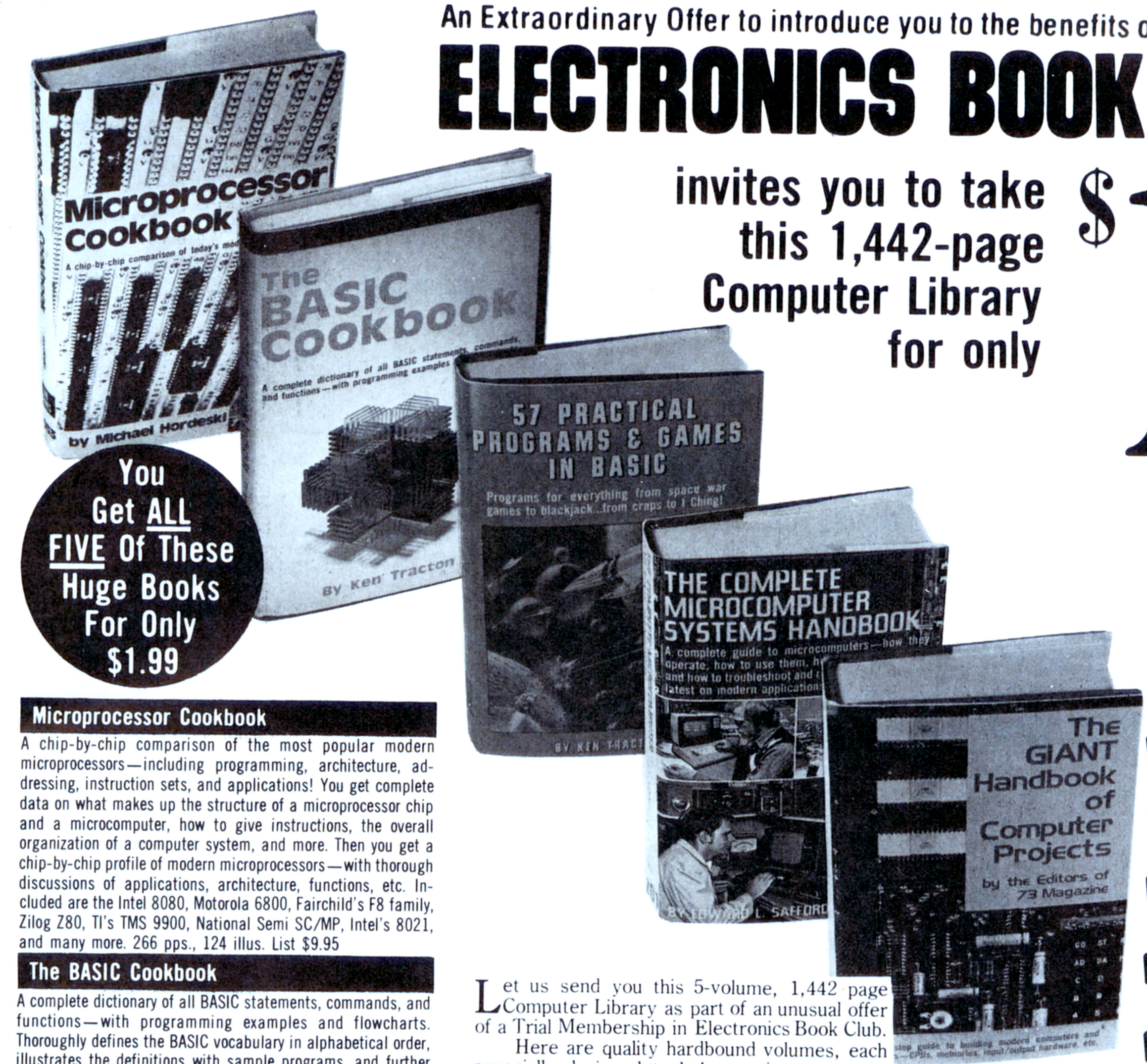
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```
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G3ZCZ LOGON IN PROGRESS AT 1115 ON 6 NOV 1978
4 MESSAGES
READY MAILBOX
MAILBOX READY HELP
CHOOSE BETWEEN 'SEND, RETRIEVE, HELP, SPACE, LOGOFF'
MAILBOX READY SPACE
DISC SPACE = 25K
MAILBOX READY SEND
DESTINATION? WB4APR
INPUT: —       BOB, WE HAVE TO DISCUSS THE RADIO PROTOCOL. CALL ME WHEN YOU HAVE A MOMENT, BETWEEN 9 AND 11
               PM ANY NIGHT EXCEPT FRIDAY. [control-Z]
MESSAGE ACCEPTED
MAILBOX READY RETREIVE
RETREIVE IS NOT VALID
MAILBOX READY RETRIEVE


 MESSAGE                    SOURCE                          DATED
      1                     WB4APR                          1 NOV 1978
      2                     CMC 105                         3 NOV 1978
      3                     TERRY FOX                       5 NOV 1978
      4                     G8BTB                           5 NOV 1978


MAILBOX READY RETRIEVE 2
MESSAGE READS:          BRING THE DOCUMENTATION ON THE GLOOP BOX TO THE MEETING. FRED.
MAILBOX READY
```

Figure 3: *Sample interaction between the author (G3ZCZ) and the Chesapeake Microcomputer Club-Amateur Radio Development Association (CMC-AMRAD) computer system. Characters sent by the system are shown in regular type; those typed by the user are shown in boldface type. Note that when the "RETREIVE" command (a misspelling) is entered, an error message is generated by the system.*

return character so that the computer can set up the correct data rate. Once the data rate is established, the computer sends out a sign-on message and asks the user to log in with an identification code. This identification can be a membership number, an amateur radio call sign, or some arbitrary name. It is limited to a length of eight characters. The computer will then indicate the presence or absence of any personal messages addressed to the user that has just logged in.

The software in each computer is identical in behavior and is organized in a structured top-down approach as shown in figure 2. The user has a choice of programs as shown that perform the various functions. Various commands are associated with each program as listed. Consider each program and mode in turn.

The *mailbox* program is designed to enable club members to send short messages (up to 256 characters) to each other. The messages are in plain language. The response to a SEND command is to prompt the user with DESTINATION? Upon entering the identification code of the destination, the user is prompted to send the message and terminate it with a control-Z character. Should more than 256 characters be entered, the entire message will be rejected. This discourages long messages.

The response to the RETRIEVE command is to list the sender identification of each message in the system awaiting the user.

A sample user session is shown in figure 3. The computer output is shown in regular type, the user input in boldface type.

The other messages may be retrieved in turn. The RETRIEVE command has the following characteristics: If followed by a carriage return, it lists all messages. If followed by a 0, it lists all messages. If followed by a number, it lists the corresponding message.

Identification numbers are assigned to the messages only to allow the user to retrieve them. The numbers are reassigned as messages are deleted.

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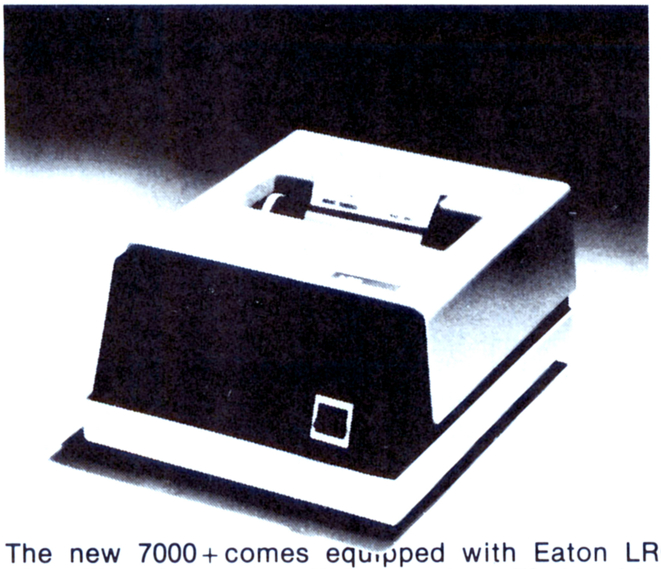

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Deletion of messages is allowed by the system under restricted conditions. Only the system manager, the sender, or the retriever can delete messages. Each user is assigned a password that must be entered prior to a DELETE command. This allows some degree of security. Messages will be deleted by the system manager periodically, depending on the storage requirements of the system.

In the *news* and *fleamarket* modes, updates are handled by a single club member designated for that duty. All messages for input to the system are routed to this person for scanning before being placed on the system. This is to keep the system from being cluttered up with undesirable messages. Updates of these messages take place as time permits, with a maximum delay time of one week.

The *conversion* program is designed for exchange of data between different media. One club member desiring to receive a data file from another will arrange for the second member to put the file into the system for retrieval within hours. The expected life of a file in the conversion mode is about 24 hours. Conversion uses a different protocol than the mailbox mode. Since long files are being exchanged, the data flow has to be stopped from time to time to allow disk read and write operations. A full-duplex mode is used.

The maximum message length of 256 characters applies in all modes except conversion. Messages with more than 256 characters are rejected in their entirety. This encourages brevity. A rejection message is printed by the computer to the sender in the case of a message rejection. A user who has to retype messages will soon get the idea.

Several existing network systems carry a large number of undesirable messages. We hope to minimize them in the CMC-AMRAD network. Any user trying to enter unwanted messages may have them rejected by the system manager.

Data Complexity Levels

Data may be transmitted over a link at one of several levels of complexity of internal organization. The basic level (level 0) is plain ASCII-encoded text in half-duplex mode. Level 1 is a simple ASCII-based, full-duplex mode developed by Tim Pugh. Level 2 is an emulation of the PCNET (personal computer network) protocol. Level 0 is used by anyone in talking to the computer during execution of any user program. Level 1 may be used in the conversion mode, while Level 2 is used for intercomputer data exchange. Any properly equipped user can request any level when he logs onto the system.

Any club member having an *answer-mode modem* can run the basic network system software on his or her machine. An extension can be made to the system to allow access to the disk operating system so that other club members can play with the other software available on the machine.

Radio Restrictions

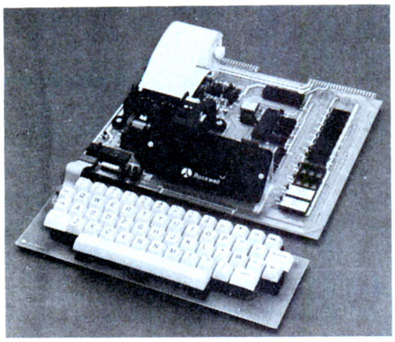
Mailbox and news are the only categories of data exchange available via radio links. Conversion-mode data may contain binary or other unusually coded files, and fleamarket may contain advertisements; radio transmission of both of these classes of messages is forbidden by law.

The procedure for logging onto the system is different from the one used over the telephone. Half-duplex mode is employed when using a single-band repeater, such as the 147.81/147.21 MHz AMRAD machine. If the inputs and outputs were on different amateur frequency bands, full-duplex operation would be easily achievable. In order to avoid the requirements for duplex exchanges and to reduce the amount of information exchanged, the modified *Q code* is employed. See my article "The Sky's the Limit: Use Ham Radio Bands for Intercomputer Communication" (November 1978 BYTE, page 48), for a more complete discussion of the use of these Q codes.

[The Q code is a system of 3-letter abbreviations that all begin with the letter Q. Various Q codes are used during Morse-code radio transmissions to speed up message exchange. An adapted set of Q codes is used for computer network communication... **RSS***]*

Any amateur can log into the network and receive a reply from any on-line computer that has a message for him or her. Thus, users without computers can store their messages in the network computer; those with computers can leave messages on their own machine for later remote retrieval. Possible contention interference (from more than one machine simultaneously trying to communicate over the network) can be overcome initially by employing a different time-delay response characteristic for each computer in the network (both user and system computers).

The radio link can also be used for long-distance links between the club network and other club networks. Again, see "The Sky's the Limit" for a more complete discussion. ■



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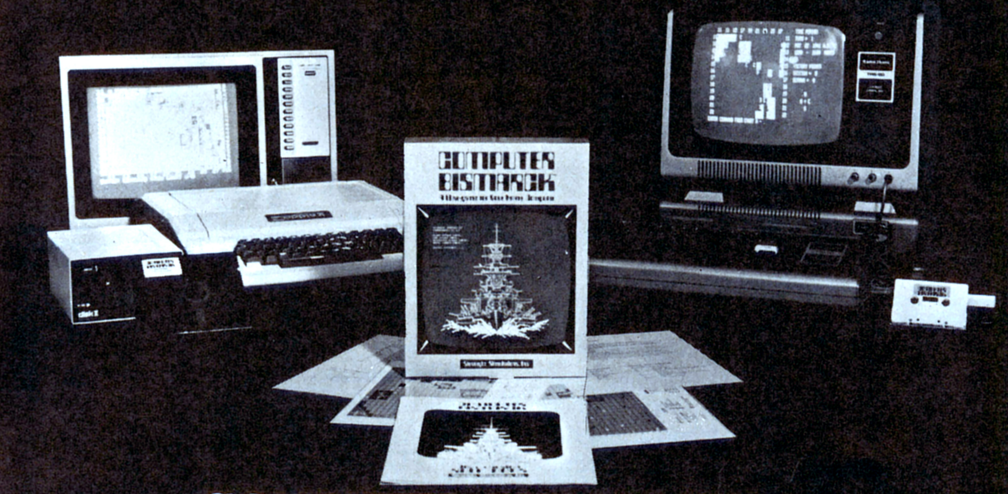

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The COSMAC Doodler

Jeff Duntemann
301 Susquehanna Rd
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When the COSMAC ELF microcomputer first appeared several years ago, its designer called it a microcomputer trainer. That meant that you had a few hexadecimal displays and a light-emitting diode (LED) to play with in your programs, and nothing else. Clever people managed to make the ELF play music or even generate Morse code without much additional hardware.

As far as I know, the ELF is the only microcomputer that has often been built from scratch by hobbyists without using a predesigned printed-circuit board. There is *no* better way to learn microprocessor hardware than to buy a handful of parts and wire-wrap all of the connections. In ironing out your mistakes, you will become familiar with every processor timing signal, every kink in every system timing diagram, and every little architectural quirk that can grow up to be a big bug in later programs. It is a rigorous education, I promise you, but an excellent one.

Then RCA released the CDP1861 video-display-controller integrated circuit for sale, and suddenly the ELF could do something no comparable computer could do for triple the price. With the CDP1861, the ELF displays a bit-map of 1024 bytes of memory on a video screen (in black and white), with no hardware needed except the CDP1861 and several resistors, and with software consisting of a 30-byte interrupt routine.

This development was not purely a gift to hobbyists, of course. The CDP1861 formed the heart of RCA's Studio One home video game. In such games cost is probably the most important factor. Video-game-type graphic displays are now easily done on the ELF. The fourth article in the ELF series ("Build the PIXIE Graphics Display," Joseph A Weisbecker, *Popular Electronics*, July 1977, page 41) outlined the hardware required and included a simple test program, but it was up to hobbyists to come up with video software to make the ELF earn its keep.

The Video Doodler program presents a winking cursor in the upper left-hand corner of the screen. By actuating toggle switches, the cursor can be made to move horizontally, vertically, or diagonally. As it moves, it either leaves behind a trail of white dots against the black background, or it "eats" previously written white dots and lines back to blackness. Once you fill the screen, one push of the INPUT switch wipes it clean again.

Memory Requirements

The only problem is the program's size. Within the limits of a typical ELF one-page memory system, there is no room left in memory after you toggle in the program to do any drawing on the screen. The only way out of this problem is to expand memory to at least two 256-byte pages. If you shop wisely, you can do this for less than $9.00. Adding another page of memory requires only two additional 2101 static memory chips and a CD4042 complementary metal-oxide semiconductor (CMOS) latch. Figure 1 details an ELF two-page memory system.

If you do not intend to add much more memory beyond two or three pages, you might consider replacing

Text continued on page 218

About the Author

Jeff Duntemann works for Xerox Corp. He has built a small robot (named Cosmo) that he controls with his computer, and enjoys amateur radio operation (as KB2JN). His writing is not confined to technical articles; he has had a science fiction story published in Isaac Asimov's Science Fiction Magazine.

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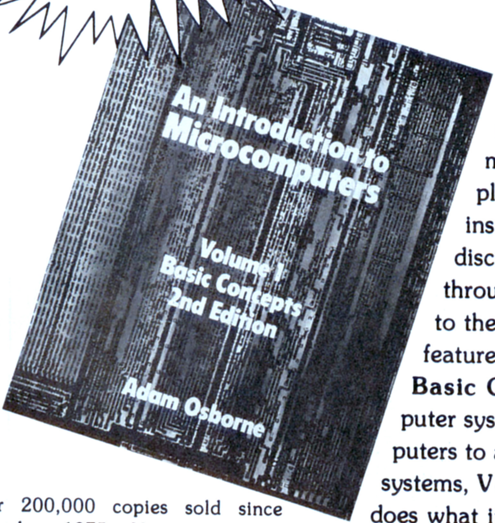

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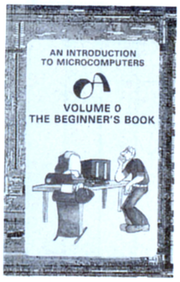

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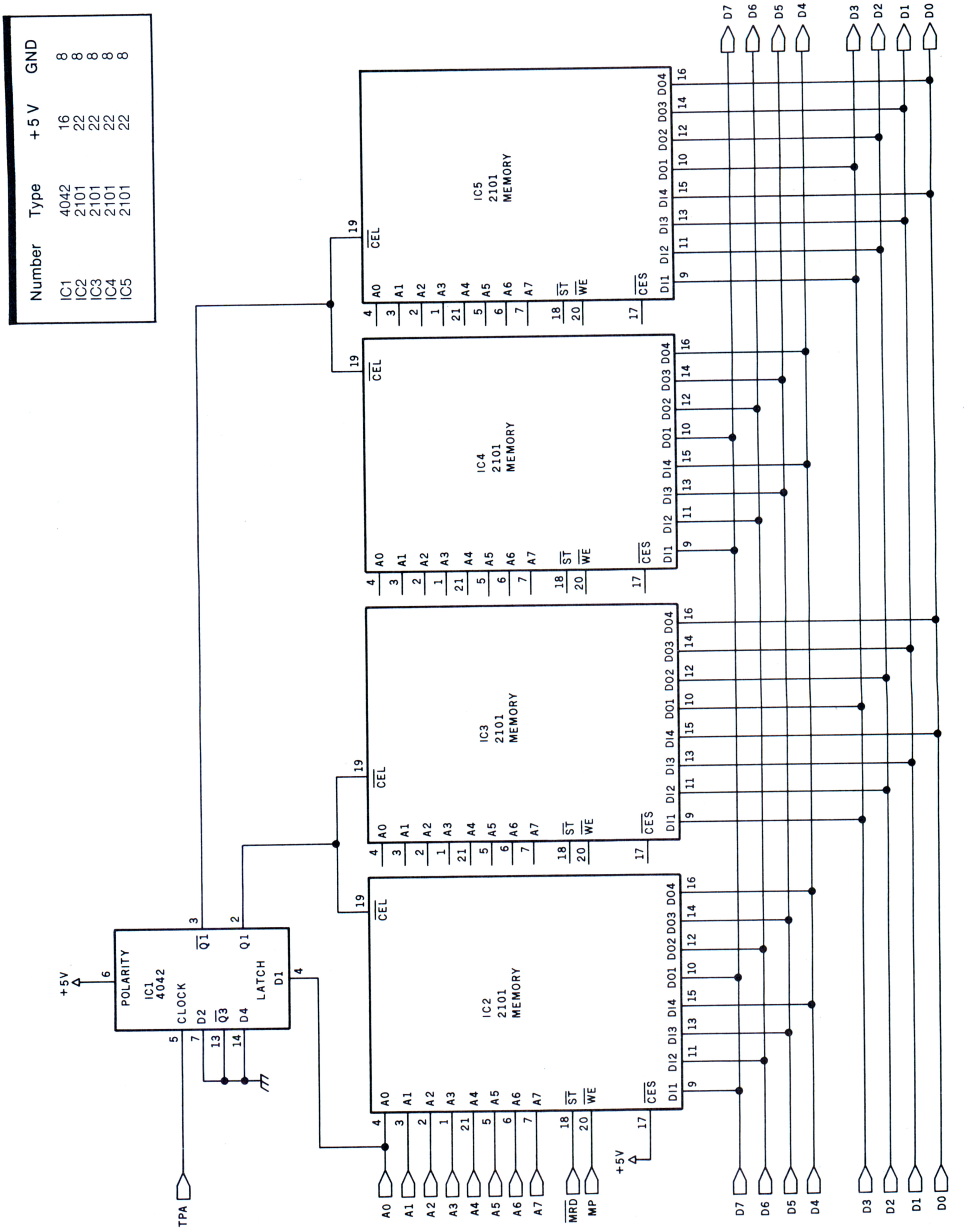

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A0
A1
A2
A3
A4
A5
A6
A7
MRD
MP
+5V
D7
D6
D5
D4
D3
D2
D1
D0
IC1
4042
POLARITY
CLOCK
LATCH
Q1
Q̄1
D1
D2
Q̄3
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IC2
IC3
IC4
IC5
2101
MEMORY
CEL
CES
ST
WE
DI1
DI2
DI3
DI4
DO1
DO2
DO3
DO4

Number	Type	+5 V	GND
IC1	4042	16	8
IC2	2101	22	8
IC3	2101	22	8
IC4	2101	22	8
IC5	2101	22	8

Figure 1: *Schematic diagram of a two-page programmable-memory system that can easily be added to a COSMAC ELF microcomputer. Pins 17 and 22 of the memory parts should not be connected together. Instead of 2101 memory devices, it is possible to substitute CMOS 5101, 74C920, or CDP1822CD parts. Use of complementary metal-oxide semiconductor memories enables the use of batteries to retain data in memory even when the main power supply is shut off.*

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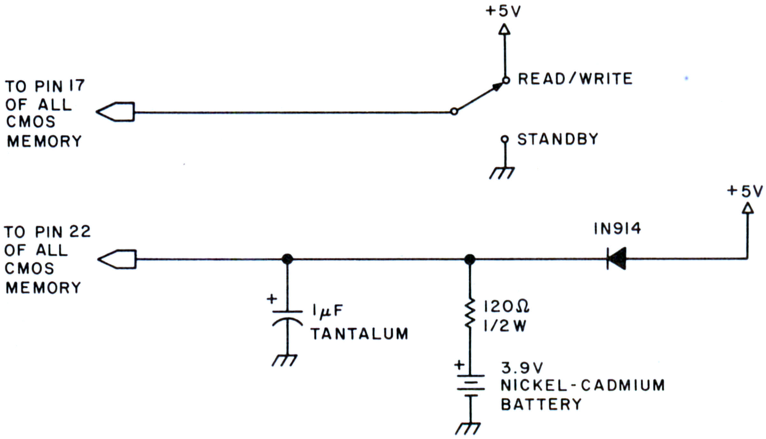
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Figure 2: *Memory data-retention circuit for CMOS memories. Do not use this circuit with a 2101-type memory. The nickel-cadmium battery cells charge during normal operation, and thereafter maintain data in the memory when main power has been turned off.*

Text continued from page 214:

your 2101 devices with CMOS 5101 or CDP1822 memory. A small 3.9 V battery can allow data to be retained in CMOS memory even when the main power is off, thus keeping you from facing the exasperating job of toggle-loading 195 bytes every time you want to show off the Doodler.

If you can locate a 3.9 V nickel-cadmium battery, the circuit in figure 2 can be built and then forgotten about. The ni-cad will charge while the power is on, and keep memory alive when power is off. If you operate your ELF at least a few hours per month, the battery will never fully discharge.

Register Use

The Doodler program makes heavy use of the COSMAC general-purpose registers. A register-use summary is given in table 1 to keep everything straight while you are trying to understand the program's operation.

Where Is the Cursor?

It takes two pointers to specify a cursor position on the screen. The *byte pointer* is the memory address of a single byte somewhere among the 256 bytes displayed on the screen.

The *bit pointer* is a byte stored in half of a general-purpose register. Only one bit of this byte ever contains a binary 1. This bit represents the position of the cursor within the byte indicated by the byte pointer.

The Doodler actually has two sets of pointers for its cursor. The permanent pointers contain the actual position of the cursor at any given time. The temporary pointers are modified during each scan of the toggle switches.

The toggle switches are read and separately tested by shifting bits out of the D register (COSMAC's accumulator). Each of the first five switches controls a program function. If the first toggle switch is actuated, the temporary bit pointer is shifted one bit to the right. If during this shift the bit crosses over into the next byte, the temporary byte pointer is incremented by one.

Actuating the second toggle switch shifts the bit pointer to the left, and decrements the byte pointer if the bit crosses the border into the next byte leftward. The third toggle switch adds the hexadecimal value 08 to the byte pointer. This does not affect the

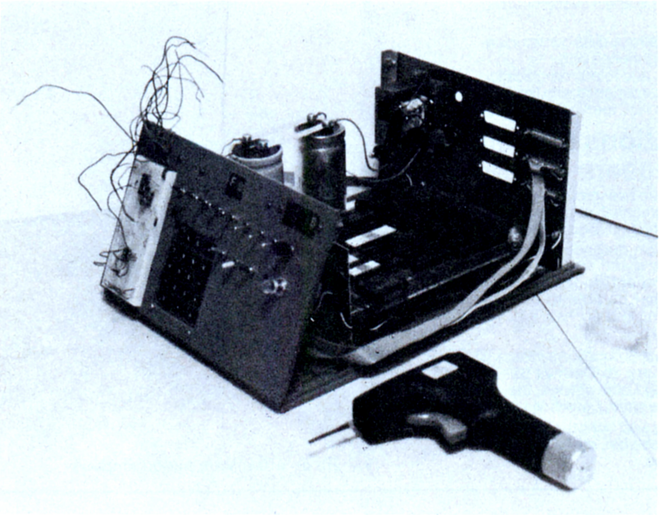


Photo 1: *The author's homebrew COSMAC computer system. It contains 2560 bytes of memory and uses a full 16-bit address display. Important processor and input/output signals are brought out through the front panel for ease in breadboarding.*

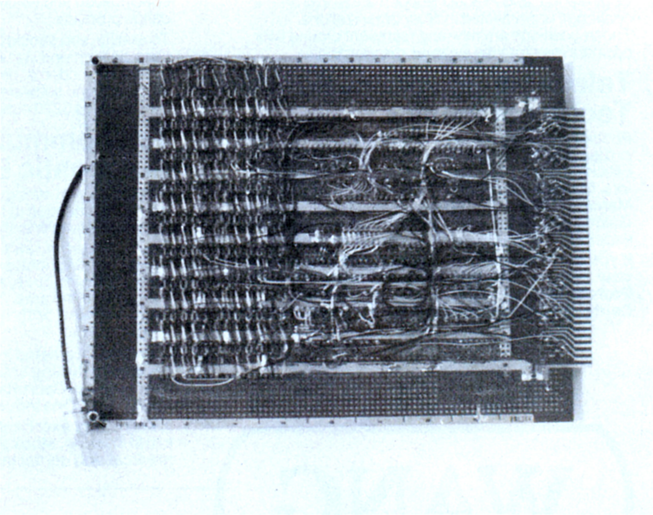
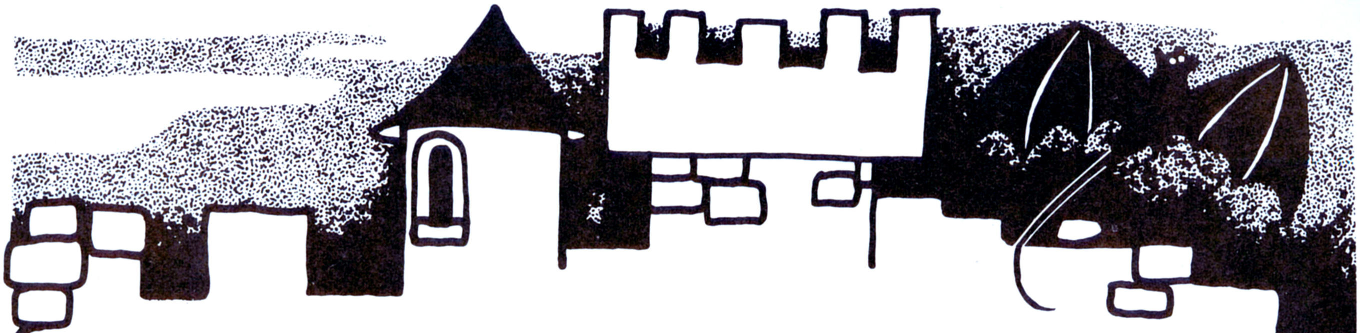


Photo 2: *Bottom side of the processor board. Six weeks of evening work with an OK Tool Hobby Wrap wire-wrap gun and 150 feet of wire were needed to complete the connections.*



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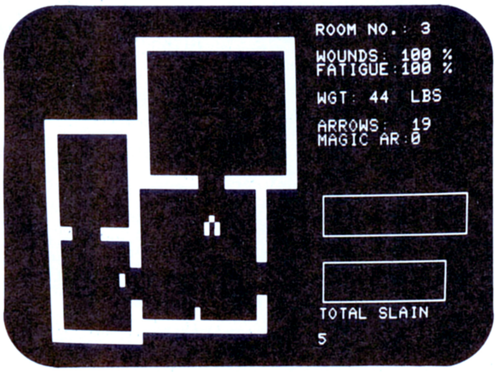

```
ROOM NO.: 3
WOUNDS: 100 %
FATIGUE:100 %
WGT: 44  LBS
ARROWS: 19
MAGIC AR:0
TOTAL SLAIN
5
```

Actual photo of screen during a Dunjonquest game. In Room 3 in the Temple of Apshai, our hero observes two treasures unattended by dragons, monsters or demons . . . for the moment. He is completely free of wounds; he is not at all fatigued. He carries 44 pounds of armor and 19 arrows in his quiver. He has already slain five demons. Will he capture the treasures before moving on . . . or before the forces of darkness intercept him?

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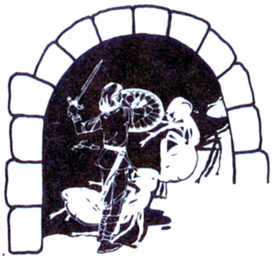

*California residents, please add 6.5% tax.

cursor's horizontal position (the bit pointer remains the same), but the cursor is moved down one row. Similarly, the fourth toggle switch subtracts hexadecimal 08 from the byte pointer. This makes the cursor move one row upward.

Only after the toggle switches have been completely scanned are the values in the temporary pointers transferred to the permanent pointers, and the cursor moved to its new position. This makes motion on the diagonal possible without visible up-and-across motion on the way to the new position. If all four toggles are actuated, the cursor does not move. The four motions cancel one another before any information is transferred to the permanent pointers.

The fifth toggle switch determines whether the bit written into the cursor position will be a white dot or a blank space.

Register	High Byte	Low Byte
0	Direct-memory-access pointer	Direct-memory-access pointer
1	Interrupt program counter	Interrupt program counter
2	Stack pointer	Stack pointer
3	Main program counter	Main program counter
4		
5	BNKWRT program counter	BNKWRT program counter
6	DOTWRT program counter	DOTWRT program counter
7		
8	DELAY program counter	DELAY program counter
9	Temporary byte pointer	Temporary byte pointer
A	Inter-shift D storage	Temporary bit pointer
B	Permanent byte pointer	Permanent byte pointer
C		Permanent bit pointer
D	Blanking pointer	Blanking pointer
E	Delay-timing constant	Delay-timing constant
F		

Table 1: *Use of COSMAC 1802 16-bit registers by Video Doodler program.*

Operation of Subroutines

Two subroutines accomplish the transfer of information from temporary to permanent pointers and the final writing of the cursor bit onto the screen. If the fifth toggle is actuated, subroutine BNKWRT does the job and writes a 0 (blank) into memory at the cursor position. If the fifth toggle is not actuated, the job is done by DOTWRT, and the cursor leaves a white dot behind in memory and on the screen.

A third subroutine, DELAY, slows the process down so that you can direct the cursor intelligently on the screen. The execution time for DELAY (and thus the speed at which things happen) is determined completely by the constant that begins at memory location 0046. You increase or decrease this constant to slow the program or speed it up.

Text continued on page 224

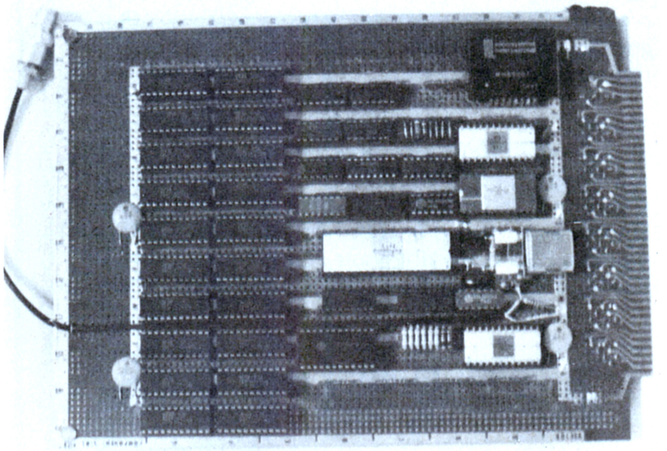

Photo 3: *Component side of the processor board. The video signal is brought off the board by the miniature 75-ohm coaxial cable.*

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Photo 4: *Display produced using the Video Doodler. The isolated dot at the center right is the winking cursor.*

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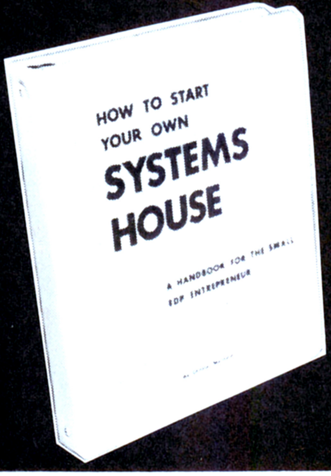

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Listing 1: *Video Doodler program in machine code for the COSMAC ELF.*

```
Address   Hexadecimal Code          Comments

  00      F8  00  B1  B2  B3  B5    Initialize high-order registers
  06      B6  B8  A9  AB            and byte pointers
  0A      F8  01  B9  BB  BD
  0F      F8  80  AC  AA            Initialize bit pointers
  13      F8  28  A1                Initialize interrupt PC
  16      F8  FF  A2                Initialize stack pointer
  19      F8  66  A3                Initialize MAIN PC
  1C      F8  5A  A5                Initialize BNKWRT PC
  1F      F8  4F  A6                Initialize DOTWRT PC
  22      F8  45  A8                Initialize DELAY PC
  25      D3                        Begin executing MAIN PC
                          INTERRUPT
  26      72  70                    Restore D, X, & P
  28      22  78  22  52            Push P, X, & D onto stack
  2C      C4  C4  C4                NOP s for sync delay
  2F      F8  01  B0  F8  00  A0    Re-point R0 to display page
  35      80  E2                    Prepare for first DMA cycle
  37      E2  20  A0                DMA reset
  3A      E2  20  A0                DMA reset
  3D      E2  20  A0                DMA reset
  40      3C  35                    Test for refresh done
  42      30  26                    Go to return
                          DELAY
  44      D3                        Return to MAIN
  45      F8  07  BE                Load timing constant into RE
  48      2E                        Decrement RE
  49      9E                        Load RE.1 into accumulator
  4A      3A  48                    Loop again if not done
  4C      30  44                    Go to return
                          DOTWRT
  4E      D3                        Return to MAIN
  4F      89  AB                    Update byte pointer
  51      8A  AC                    Update bit pointer
  53      EB                        X=B
  54      F1                        Combine bit pointer & screen via OR
  55      5B  E2                    Write dot to screen
  57      30  4E                    Go to return
                          BNKWRT

  59      D3                        Return to MAIN
  5A      89  AB                    Update byte pointer
  5C      8A  AC                    Update bit pointer
  5E      FB  FF                    Inverts D via XOR IMMEDIATE
  60      EB                        X=B
  61      F2                        Combine bit pointer & screen via AND
  62      5B  E2                    Write blank to screen
  64      30  59                    Go to return
                          MAIN
  66      E2  69                    Turn CDP1861 on
  68      3F  75                    Skip clearing routine unless INPUT pressed
  6A      F8  FF  AD                Point RD to top of display page
  6D      ED                        X=D
  6E      F8  00  73                Store 00 on screen & decrement pointer
  71      8D                        Load pointer into D
  72      3A  6E                    Loop again if not done
  74      5D                        Store 00 in last byte of display page
  75      E2  6C                    Input toggles
  77      F6  33  89                Tests "move right" bit & branches
  7A      F6  33  98                Tests "move left" bit & branches
  7D      F6  33  A7                Tests "move down" bit & branches
  80      F6  33  AF                Tests "move up" bit & branches
  83      F6  3B  B7                Tests dot/blank bit
  86      7B                        Turn Q on
  87      30  B7                    Go to EXECUTE
  89      BA                        Store D in RA.1
  8A      8A                        Fetch temporary bit pointer
  8B      F6  33  92                Shift right and test for border cross
```

Listing 1 continued on page 224

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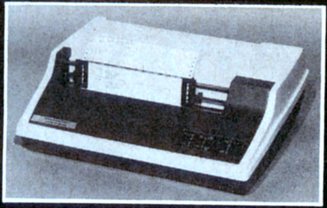

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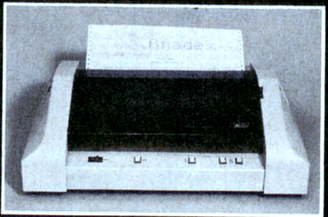

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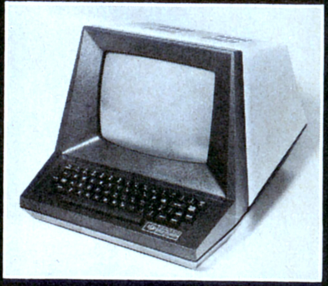

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Listing 1 continued:

```
8E          AA                      Update bit pointer
8F          9A  30  7A              Put old D back in D & return to shift & test
92          19                      Increment temporary byte pointer
93          76                      Shift bit back into other end of bit pointer
94          AA                      Update bit pointer
95          9A  30  7A              Put old D back in D & return to shift & test
98          BA                      Store D in RA.1
99          8A                      Fetch temporary bit pointer
9A          FE  33  A1              Shift left and test for border cross
9D          AA                      Update bit pointer
9E          9A  30  7D              Put old D back in D & return to shift & test
A1          29                      Decrement temporary byte pointer
A2          7E                      Shift bit back into other end of bit pointer
A3          AA                      Update bit pointer
A4          9A  30  7D              Put old D back in D & return to shift & test
A7          BA                      Store D in RA.1
A8          89                      Fetch temporary byte pointer
A9          FC  08                  Add 08 to D & put sum in D
AB          A9                      Update byte pointer
AC          9A  30  80              Put old D back in D & return to shift & test
AF          BA                      Store D in RA.1
B0          89                      Fetch temporary byte pointer
B1          FF  08                  Subtract 08 from D & put difference in D
B3          A9                      Update byte pointer
B4          9A  30  83              Put old D back in D & return to shift & test
                            EXECUTE
B7          D5  D8  D6  D8          Generate one "wink" of cursor
BB          31  C0                  Go to M(C0) if Q is on
BD          D6                      Call DOTWRT & write on screen
BE          30  68                  Go to test for clear
C0          D5                      Call BNKWRT & write on screen
C1          7A                      Turn Q off
C2          30  68                  Go to test for clear
```

Text continued from page 220:

One novel effect may be produced by changing the sequence of bytes beginning at location 0046 to 01, AE, 2E, 8E. This permits the program to run at maximum speed. The cursor will streak across the screen almost too quickly for the eye to follow. As you flip the toggle switches up and down, it will paint a crazy-quilt pattern across the screen.

To clear the screen, simply hold INPUT depressed while flipping RUN up. This branches to a simple routine that writes zeroes consecutively in memory from the top of the displayed page on down.

Design Storage

Saving a design produced with the Doodler for later display involves dumping the contents of the display page of memory into some mass-storage medium. Lacking a cassette tape interface or some other storage, you will have to step through memory and write the hexadecimal contents of each byte in the page.

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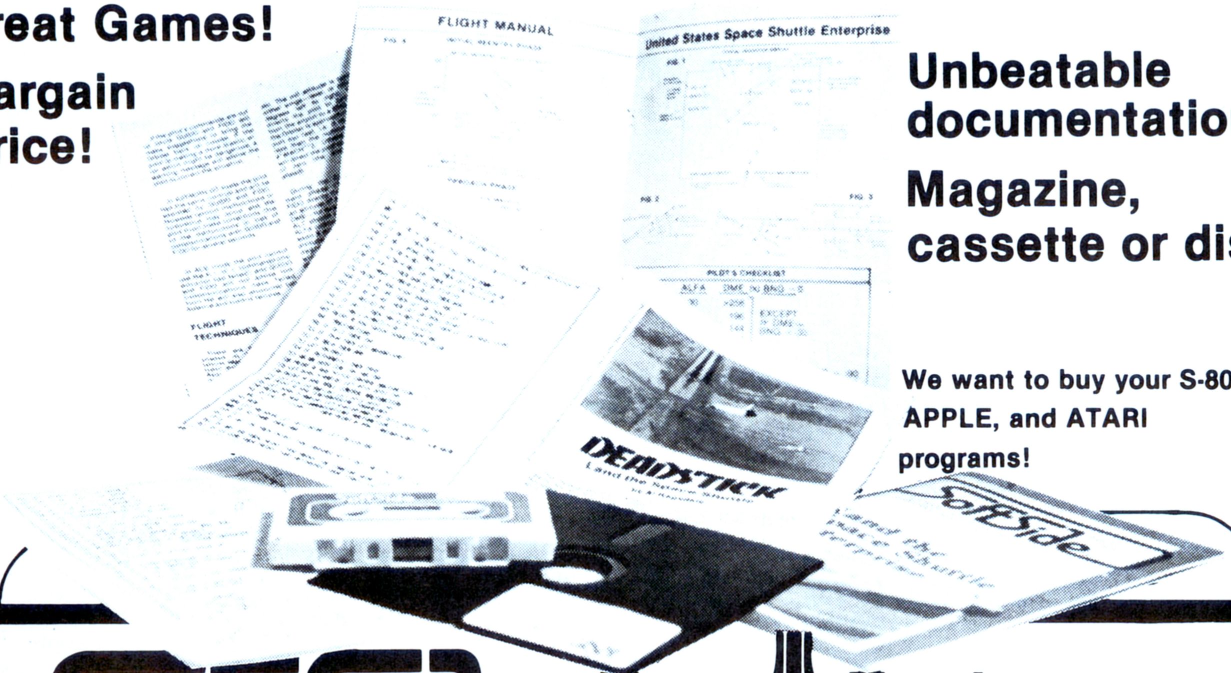

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Book Reviews

TRS-80 Assembly Language Programming

William Barden Jr
Radio Shack, 1979
224 pages, softcover
$3.95

"The goal of this book is to take a TRS-80 user familiar with some of the concepts of programming in BASIC and introduce him to TRS-80 assembly language." With that statement in the preface, Mr Barden proceeds to do exactly that. He introduces the user of the Radio Shack TRS-80 computer to that mysterious element of programming called assembly language.

For you old-timers, *TRS-80 Assembly Language Programming* is a refreshing review of how we used to program way back in the good old days. For you novices, perhaps discouraged after trying to debug a BASIC program, this book is the change of pace you need. Throw away, or at least put aside, that BASIC user's manual, type in "SYSTEM" when the prompt character appears, and load that Editor/Assembler or TBUG tape you just bought. Now you are going to see what computer programming is all about!

Although the author states that the Radio Shack Editor/Assembler package or its equivalent is not a requirement, you will miss half the fun of reading this book if you do not have it. Also, TBUG is recommended by the author in order to fully appreciate some material.

Barden has developed a unique presentation to introduce and explain the general concepts of the TRS-80 assembly language, the mnemonic system for the Z80 microprocessor. I say a unique presentation because this is the first assembly-language book which I have enjoyed reading. Barden is not averse to injecting a little humor into his writing. After all, who says that programming books should be all bits, bytes, and syntax restrictions?

Barden begins with the architecture of the Z80, its instruction set, and its addressing modes. He then proceeds through the Editor/Assembler and the TBUG commands and formats in the first section of the book.

There is quite a bit of information packed within these first eighty-four pages, and it pays to read through Section 1 with a highlighting marker in hand. In fact, I skimmed through these pages for my first reading and then reread them more carefully the second time. This method tends to fix certain important details in your mind and will act as a referencing tool.

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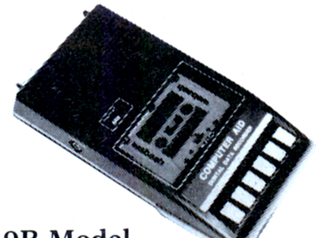

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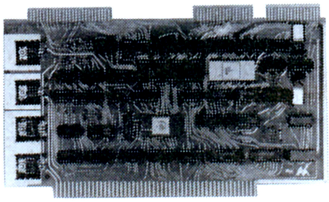

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tion 2. Barden not only explains the how and the why of assembly language, but does so with useful examples of assembly-language coding. When he explains how to move data, he does it by coding the instructions and discussing the pertinent background. Arithmetic and comparison operations, logical and bit operations, shifting, strings, and tables are explained and presented with appropriate coding. If you have TBUG or Editor/Assembler, you can code along with the text and actually see the operations being executed. This interactive approach works well.

In *TRS-80 Assembly Language Programming*, Barden handles the discussion of input/output (I/O) operations in an easily readable, yet informative fashion. After you complete this phase of your education, the mystery of assembly language magically evaporates, and you are ready to tackle some sophisticated assembly-language programming.

But that's not all. Barden ties together most of the loose threads by including some interesting and useful subroutines. If you want a quick routine to fill a block of memory with any given 8-bit value or move the contents of a block of memory from one area to another, you need only assemble the subroutines already coded for you and presented in the book.

Some arithmetic subroutines are also given: adding or subtracting operands containing up to 256 bytes, and multiplying or dividing 16-bit numbers. The compare subroutine is useful since it compares two 8-bit operands in true algebraic fashion. A routine for converting an 8-bit value into two American Standard Code for Information Interchange (ASCII) characters is included, as is a search subroutine. Finally, three subroutines that operate in a manner similar to the SET, RESET, and POINT statements in BASIC are given in the book.

Barden offers four complete assembly-language programs to start your program library off on the right foot. These perform the functions of writing data to the screen (good for looking at the contents of memory locations), moving patterns at high speed (great for animated graphics), a graphic bubble sort (good for demonstrations), and a program to play music via the cassette output port.

The appendices include a listing of the Z80 instruction set and a listing of the Z80 op codes. (For quick reference to Z80 mnemonics, Zilog offers the *Z80-CPU Programming Reference Card*, which I have found more convenient to use than flipping through the pages of a book.)

One further note: William Barden is also the author of *The Z80 Microcomputer Handbook* (Howard W Sams Co Inc, 1978), which takes the Z80 software a few steps deeper into the assembly-language forest.

So, what can you get for $3.95 in addition to Barden's excellent introductory text dealing with Z80 assembly-language programming? Quite possibly you will get a hard-to-shake bite from the assembly-language bug. ■

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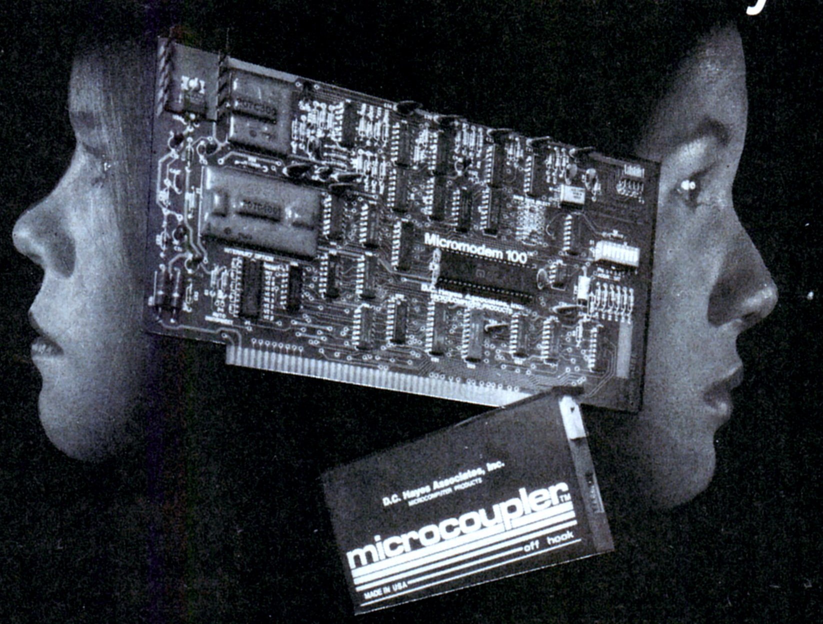

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Club membership is open to all those that are interested in using microcomputers for fun and business. Membership dues are $5 per year. The club meets the first Monday of each odd-numbered month at McKinley Community School, 461 McGilchrist St, Salem, Oregon. On even-numbered months, they meet at Computer Pathways Unltd Retail Store, 831 Lancaster Dr, Salem, Oregon. A monthly newsletter is published. Each meeting features a presentation by a club member or invited guest. For information, contact Salem Area Computer Club, c/o Doug Walker, 4554 Jan Ree Dr NE, Salem OR 97303.

North London Hobby Computer Club (NLHCC)

The NLHCC has scheduled their meetings for the next 3 months. The theme for the May meeting is "Computer-Aided Instruction." The meeting will be held May 7 at 7 PM in the Students Common Room in the Polytechnic of North London. On June 4, the meeting is entitled "The House Computer." July third's meeting is on "The Personal Computer and Restel/Teletext." Contact NLHCC, Holloway, London N7 8DB, ENGLAND.

TRS-80 Users Group of Sacramento

The TRS-80 users group of Sacramento meets at the Sacramento Country Branch Library, 2443 Marconi Blvd (Marconi and Fulton), Sacramento, California, from 7 to 10 PM as called. For more information, contact the TRS-80 Users Group of Sacramento, POB 255704, Sacramento CA 95825.

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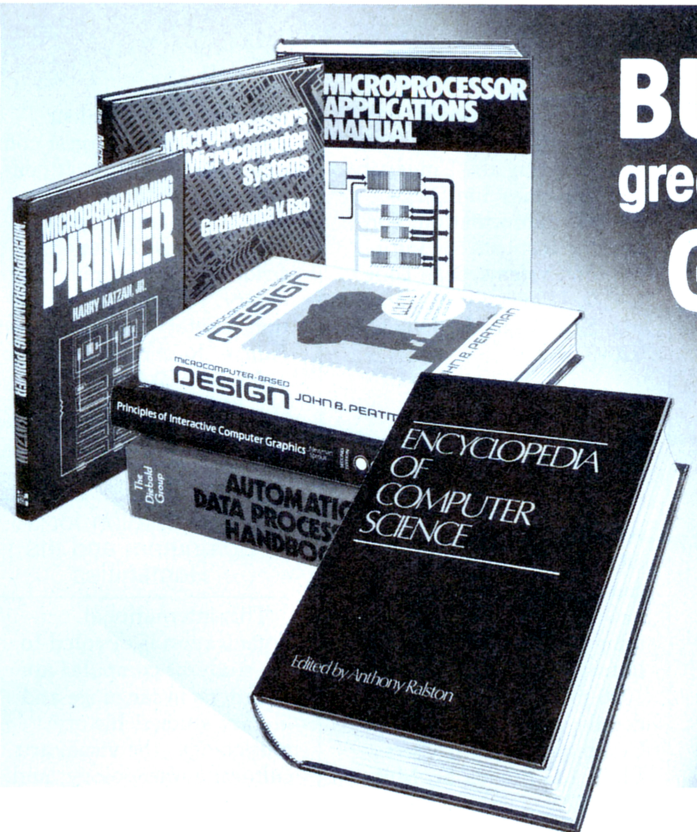

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Central Oklahoma Amateur Computing Association (CENOACA)

CENOACA meets the second Saturday of each month at the OSU Technical Institute, 900 N Portland, Oklahoma City, Oklahoma, at 10 AM. Their purpose is to acquaint beginners with personal computing and increase their knowledge of special interest areas, including SwTPC and 6800 systems. Their newsletter, *CENOACA Newsbits*, is published on an irregular basis. Contact CENOACA, POB 2213, Norman OK 73070.

Another Group in Florida

The Space Coast Microcomputer Club meets on the fourth Thursday of each month at 7:30 PM in the Merritt Island Public Library Auditorium. They are affiliated with the JF Kennedy Space Center at Cape Canaveral. The group publishes *Enterprise*, a monthly newsletter. The primary interests are Z80, 8080, and S-100 systems. Dues are $5 per year, and inquiries should be sent to Ray O Lockwood, 315 Inlet Ave, Merritt Island FL 32952.

APL Newsletter

A quarterly newsletter describing tools, techniques, services, and containing general news of interest to APL users, is being published by Southwater Corp, 2348 Whitney Ave, Mt Carmel CT 06518. Subscriptions are $6 annually and requests should be sent to *APL Market Newsletter*, at the above address.

Newsletters on the UCSD Pascal System

The Institute for Information Systems is publishing newsletters describing the UCSD Pascal System developed by the University of California, San Diego. For more information, contact the Institute for Information Systems, mail code C-021, University of California, San Diego, La Jolla CA 92093.

Apple Users Group

The Goldcoast Computer Apple II Users Club desires additional members. The group publishes a monthly newsletter with programming tips, and they have a library selection of over 1000 programs. Send for details: Florida's Goldcoast Computer Apple II Users Club, 133 Brenda St, Milton FL 32570.

Feedback From Fujitsu

Feedback From Fujitsu is a newsletter from Fujitsu Limited, Japan's largest computer manufacturer. It contains items concerning discoveries and general business news of Japan's strides in the computer industry. For more information, contact *Feedback From Fujitsu*, Ruder and Finn Inc, 110 E 59th St, New York NY 10022.

Association for Computers and the Humanities

This international organization is devoted to the study of computer applications in language and literary studies, history, musicology, the visual arts, cultural anthropology, and other related social sciences. Members of the association are entitled to discount at the International Conference on Computers and the Humanities and the meetings of the Association for Literary and Linguistic Computing. The annual dues are $15, and a quarterly newsletter is available for $15 per year. For details, write Association for Computers and the Humanities, Queens College, Flushing NY 11367.

Computers and Gambling Magazine

This quarterly magazine is oriented toward computer hobbyists interested in using computers for all types of handicapping systems, card counting systems, and techniques for stock and future markets investments. Articles describe products and techniques for the computerized gambler, and advertising of products and personal computers is included. Sample issues are available for $1. Subscriptions are $5 per year and may be obtained by writing to Joe Computer, 22713 Ventura Blvd, Suite F, Woodland Hills CA 91364. ■

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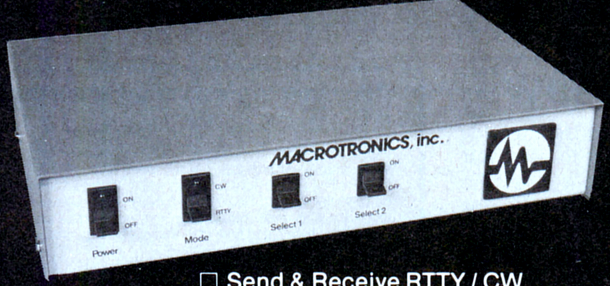

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Observations from BYTE's Ongoing Monitor Box, The BOMB

As the card says, BYTE's BOMB is your direct line to the editor's desk. Ever since the third issue of BYTE (November 1975), BYTE's editors have used the BOMB as an important source of information on how readers react to our magazine. Therefore we thank the readers who have mailed the BOMB card to us and included their comments.

Occasionally we like to share with you some of the more interesting responses received on these cards. The most pictorial BOMB card in recent memory came from a reader in Hackensack, New Jersey, shown front and back in photos 1 and 2. It seems our friend in New Jersey was generally pleased with our January 1980 issue.

Regretfully not all of our readers have been as well pleased. On one February 1980 BYTE BOMB card most of the articles were rated as being of poor quality, and a single word appeared in the "Comments" section: "PHOOEY." Yet another BOMB card for February said: "Your best issue in my 3 years!!" Clearly, a split decision.

If you have wondered when we stop accepting BOMB cards for a given issue, we cut off tabulation during the second week of the month after the cover date of an issue.

If you have never sent in a BOMB card, but intend to do so, please observe the following points. The card should be sent to our offices in Peterborough, New Hampshire. The card is presently not postpaid, but $0.10 US postage will suffice for most readers. The card is intended to record your subjective opinion, so just write your reaction, and put any specific comments on the bottom of the card. You are free to remain anonymous, but you may put your name and address on the card if you wish. In any case, letting us know your responses to our work helps us to work better. . . .**RSS**

The Largest Computer Store in America?

What is the largest personal computer store in America? The answer to that question is debatable, but on the East Coast, it's probably NEECO's (New England Electronics Company Incorporated) new facility in Needham, Massachusetts. The 9000-square-foot showroom was filled with a variety of hardware and software on our recent visit. President Robert Crowell told us about their new nationwide distribution subsidiary, called Microamerica, which was announced last fall and carries most of the major computer product lines.

We have noticed a marked increase in the number of large computer stores like Bob Crowell's with diverse product lines. This supermarket-like approach can be beneficial to the industry when combined with personal service to customers—a vital ingredient to any store's success.

In the West, things are also humming in the personal computer store field. Micro-Age in Tempe, Arizona, is a good example. Run by Jeff McKeever and Alan Hald, Micro-Age has been expanding. We were favorably impressed by their facility and by their approach to the market during a recent visit. . . .**CM**

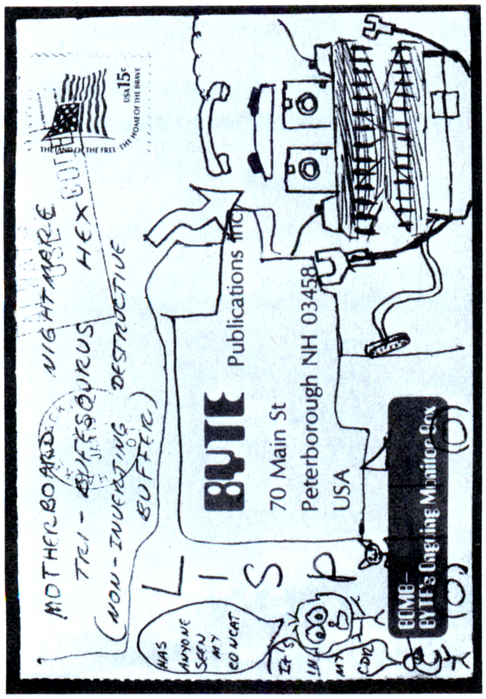
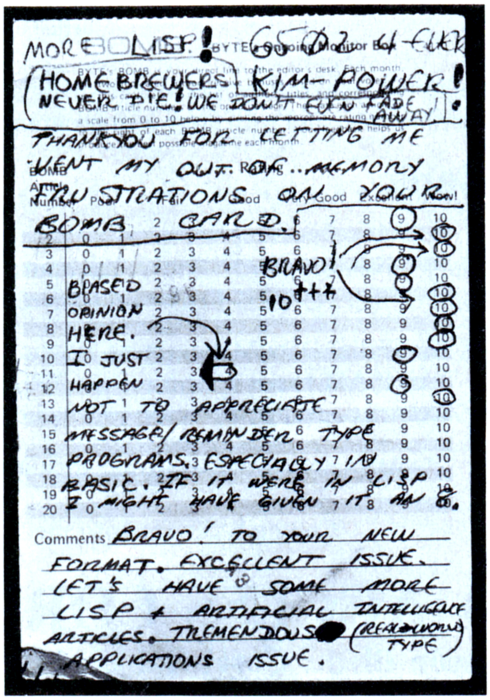


Photo 1



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BIASED OPINION HERE. I JUST HAPPEN NOT TO APPRECIATE MESSAGE/REMINDER TYPE PROGRAMS, ESPECIALLY IN BASIC. IF IT WERE IN LISP I MIGHT HAVE GIVEN IT AN 8.

Comments BRAVO! TO YOUR NEW FORMAT. EXCELLENT ISSUE. LET'S HAVE SOME MORE LISP + ARTIFICIAL INTELLIGENCE ARTICLES. TREMENDOUS (REAL-WORLD TYPE) APPLICATIONS ISSUE.

Photo 2

Texas Instruments Has an Award Winning Bubble Memory

Texas Instruments has been awarded the 1979 Information Product of the Year Award for its Model 763 Bubble-Memory Data Terminal and Model 765 Portable Bubble-Memory Data Terminal. Both terminals have a full, 128-character, alphanumeric keyboard. Up to 80,000 characters can be collected and stored in the nonvolatile bubble memory, then transmitted at rates from 110 to 9600 bits per second (bps) to a host computer system. Both units have a quiet 30-character-per-second (cps) print speed and built-in acoustic coupler modem.

A bubble memory is a small electromagnetic circuit that stores digital information by changing the magnetic polarity of a thin, crystalline film. The bubbles are cylindrical magnetic islands polarized in a direction opposite from that of the film. Bubble memory has no moving parts, and, because it works magnetically, retains information when the power is turned off. It offers higher access

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A. No, you determine format and file size to fit your requirements. You may have as many as 22 fields or as few as 1.

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A. For the most part, yes.

Q. What are the limitations? What programs can I produce with "THE CREATOR®"?

A. Your own ingenuity and hardware limitations.

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speeds, smaller size, and less weight and power consumption over paper-tape, cassette and floppy-disk systems. Bubble memory terminals can access any indexed record in memory in less than 15 ms (ie: 10 times faster than a floppy disk). If the data location is unknown, the character-string-search speed is 1000 cps, about 4 times the speed of a cassette search.

For more information, contact Texas Instruments, POB 1444, M/S 7784, Houston TX 77001.

The Fifth Annual California Computer Swap Meet

The Fifth Annual California Computer Swap Meet will be held on June 1, 1980, from 10 to 6 PM at the Santa Clara County Fairgrounds (344 Tully Rd, San Jose CA). Last year's event, held in September at the San Mateo County Fairgrounds, was attended by over 3000 buyers.

Personal computing hardware and software will be sold by individuals, computer manufacturers, and computer stores. New software and hardware, as well as used, will be offered by vendors and individuals who have cleaned out their back rooms and garages for the event. Admission is free to buyers. Contact the Fifth California Computer Swap Meet, POB 52, Palo Alto CA 94302, or call 415-324-2404.

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Meteor burst transmission has proven reliable and cost-effective for the snow telemetry program operated by the US Department of Agriculture's Soil Conservation Service. By transmitting snowfall data from remote locations, the program has eliminated costly manual measurements.

Meteor burst transmission systems work in several stages. Remote sensors gather data while a microprocessor-controlled station emits a continuous radio signal, which bounces off a meteor trail whenever one occurs within range. When this signal reaches a transceiver at a remote site, data is transmitted via the meteor trail to the central station.

For more information, contact SRI International, 333 Ravenswood Ave, Menlo Park CA 94025. ■

BYTE's Bugs

Escher's Nationality

I was interested in the February 1980 BYTE cover and in Carl Helmers' editorial concerning the Euler Problem of Königsberg. I immediately noticed when I received the issue the similarity of the cover painting to Escher's work. However, I must take argument concerning the statement that Escher was a Swiss artist.

Maurits C Escher was born on June 17, 1898 in Leeuwarden, *Netherlands*, and died March 27, 1972 in Laren, also in the Netherlands. He was in fact a *Dutchman* whose works are almost revered today in the Netherlands. I certainly commend artist Robert Tinney for combining two of Escher's more famous prints *Drawing Hands*, from January 1948, and *Reptiles*, from March 1943. However, the sequence of reptiles in Escher's original work came around and completed the cycle, by returning to the flat paper, whereas these "dragons" seem to disappear around the corner.

Naturally, the Towers of Hanoi did not go unnoticed either.

My commendation to Mr Tinney, but I think that the history of Escher, who may have been the world's greatest graphic artist, should be given correctly.

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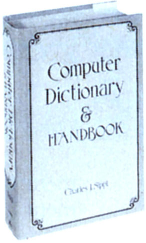

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Event Queue

MAY 1980

May and June

Microprocessor Training Courses, Cudham Hall, Cudham, Sevenoaks, Kent, ENGLAND. Microprocessor familiarization, microprocessor applications for the equipment user and for the manufacturer, and microprocessor-based equipment design and development are the courses being offered by the Sira Institute Limited. Write to Conference and Courses Unit, Sira Institute Ltd, South Hill, Chislehurst, Kent BR7 5EH ENGLAND.

May 1-2

Programming Language Technology and Ada, San Francisco CA. Conducted by Anthony Wasserman, the conference will discuss concepts of programming languages including those which support Ada language definition and development activity. The course costs $450. Registration information is available from Software Research Associates, POB 2432, San Francisco CA 94126.

May 5-7

Software Principles for Management, San Francisco CA. The course is intended for managers who need to understand what software is and how to utilize it properly. Registration is $675, and additional information is available from Technology Transfer Institute, POB 49765, Los Angeles CA 90049.

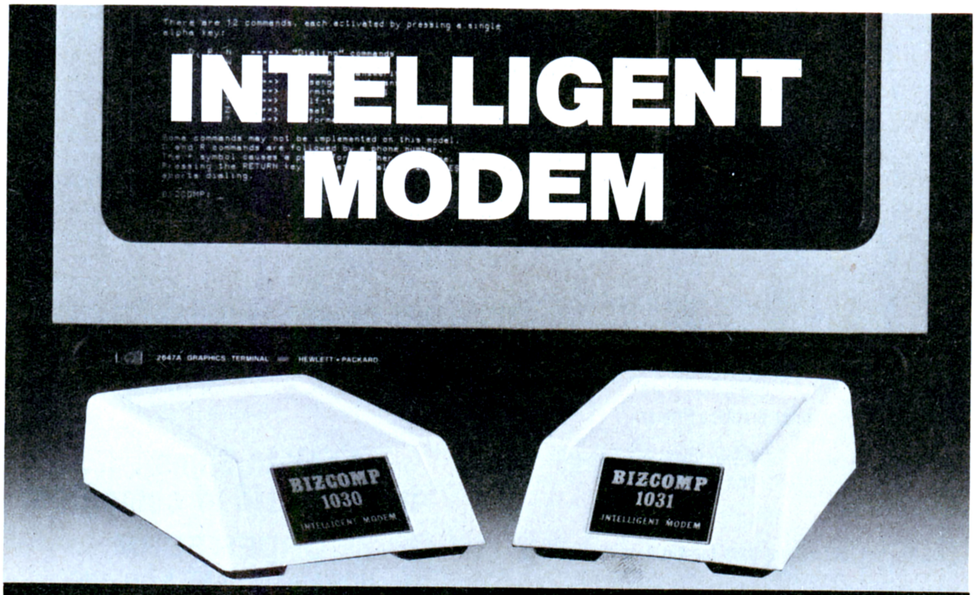
May 5-7

Data Communications, George Washington University Library, 2130 H St. NW, Washington DC. This course is intended to highlight major data communication services available, the basic choices in designing a data communications network, and essential engineering aspects of data communications. It is intended for systems analysts, engineers and managers. Contact the Director, Continuing Engineering Education, George Washington University, Washington DC 20052. The course fee is $510.

May 6-10

The Eighth Annual Canadian Association for Information Science, Toronto, CANADA. Technology, commodity, and rights are the themes of this conference. Topics will cover information in the marketplace, information transfer and policy issues, right to access, new information technologies and applications, and other subjects. For more information, contact the Program Chairman, Eighth Annual CAIS Conference, Technical Information Centre, Bell Northern Software Research, 12th Floor, 522 University Ave, Toronto, Ontario M5G 1W7 CANADA.

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, 70 Main St, Peterborough NH 03458. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.



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May 12-13
Data Communications, Worcester Polytechnic Institute, Worcester MA. This seminar is designed to help professionals develop an effective data communications system. Network design, requirements, software, diagnostics, and controls are some of the issues to be covered. The fee is $375 which covers everything except hotels. For information, contact Office of Continuing Education, Worcester Polytechnic Institute, Worcester MA 01609.

May 13-15
Microprocessors: New Directions for Mankind, Albuquerque NM. This symposium will deal with a variety of microprocessor applications. It is part of the Ideas in Science and Electronics Show. Contact J Arlin Cooper, Div 2331, Sandia Laboratories, Albuquerque NM 87185.

May 13-15
Electro/80 Show and Convention, Hynes Auditorium and Boston Sheraton, Boston MA. This show consists of presentations and exhibitions by computer industry manufacturers. Contact Electronic Conventions Inc, 99 N Sepulveda Blvd, El Segundo CA 90245.

May 13-16
The Ninth Annual Conference of MUMPS Users Group, Islandia Hyatt House, San Diego CA. This meeting will bring together scientific, medical, and business professionals to discuss current research and application development. Areas of participation are paper presentations, workshops and tutorials, and vendor exhibits. Contact Dr Jack Bowie, MUG 80 Program Chairman, The Mitre Corp, Mail Stop 641, 1820 Dolley Madison Blvd, McLean VA 22102.

May 21-22
The Second Clemson Small Computer Conference, Clemson University, Clemson SC. This program will consist of presentations, discussions and an exhibition. Emphasis will be placed on business, industry, engineering, science, and education. For registration information, contact J K Johnson, Continuing Engineering Education, Clemson University, Clemson SC 29631. For general information, contact W J Barnett, Electrical and Computer Engineering Dept, Clemson University, Clemson SC 29631.

May 21-23
Business and Personal Computer Sales-Expo 80, Philadelphia Civic Center, Philadelphia PA. This show is aimed at a wide range of interests in business and any other area that has a need for computers and computer-related products. Exhibitors will be giving demonstrations of equipment. Contact Produx 2000 Inc, Roosevelt Blvd and Mascher St, Philadelphia PA 19120.

May 23
The Digital Computer Association, Annual Meeting, Pacifica Hotel, 6161 Centinela Blvd, Culver City CA. A slide show, followed by dinner and an evening program, are the main events of the meeting. The price is $15 prepaid. Send reservations to Mary Rich, 731 Bayonne St, El Segundo CA 90245.

May 24-25
Amateur Radio and Computer Hobbyists Second Annual Convention, Cervantes Convention Center, St Louis MO. Speakers, presentations, equipment displays, and a flea market will be featured. For more information, contact the Gateway Amateur Radio Assocation Inc, POB 68, Marissa IL 62257.

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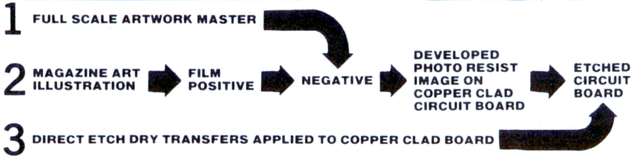
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May 31

Amateur Radio Fair, Minnesota State Fairgrounds, St Paul MN. The North Area Repeater Association is sponsoring this swapfest and exposition for personal computer enthusiasts and radio amateurs. There will be free overnight parking for self-contained campers on May 30. The admission is $3. For information, write Amateur Fair, POB 30054, St Paul MN 55175.

May 31-June 1

Microcomputers and the Physician's Office, Hyatt Regency Hotel, San Francisco CA. This seminar will provide a realistic look at microcomputer applications in the private practice. Contact Medical Data Systems, POB 193, Ojai CA 93023.

JUNE 1980

June 2-4

Improving Productivity and Distributed Data Entry, Sheraton Center, New York NY. The conference and seminar schedule includes discussions on word processing, data processing, future directions of data entry, improving data entry productivity, automated offices, installing a data-entry incentive system, and more. Contact Data Entry Management Association, POB 3231, Stamford CT 06905.

June 4-5

Microprocessors: Hardware, Software, and Application, Holiday Inn, Boston MA. This course is recommended for technical professionals who need an understanding of microprocessors in relation to their corporate and business careers. Contact Office of Continuing Education, Worcester Polytechnic Institute, Worcester MA 01609.

June 4-6

Salon de l'Ordinateur Computer Show, Place Bonaventure, Montreal, CANADA. This exhibition will feature over eighty manufacturers' hardware and software.

For more information, contact Industrial Trade Shows of Canada, 36 Butterick St, Toronto, Ontario M8W 3Z8 CANADA.

June 9-13

Microcomputer Workshop, Carnegie-Mellon University, Pittsburgh PA. Engineers, research scientists, educators, and managers will benefit from this course. It covers all aspects of microcomputers and software. Hands-on-training will be provided. The tuition is $585 and housing can be arranged. Contact the Post College Professional Education, Carnegie-Mellon University, Pittsburgh PA 15213.

June 14

Microcomputers in Business and The Professions: Systems Selection, Butler University, 4600 N Sunset Ave, Indianapolis IN. This seminar will cover various types of hardware and software, how to evaluate the kinds and performances of computers, and their applications in business and home use. The registration fee is $75. For information, contact College of Business Administration, Butler University, 4600 N Sunset Ave, Indianapolis IN 46208.

June 15-18

International Summer Consumer Electronics Show, McCormick Place, McCormick Inn, Pick-Congress Hotel, Chicago IL. The Consumer Electronics Show (CES) will feature exhibits from many companies; seminars and discussions; and items ranging from televisions, tape recorders, telephones, and translators, to computers, component systems, auto sound systems, and electronic games will be displayed. Attendance is limited to dealers and the press. Contact Consumer Electronics Shows, Two Illinois Center, Suite 1607, 233 N Michigan Ave, Chicago Il 60601.

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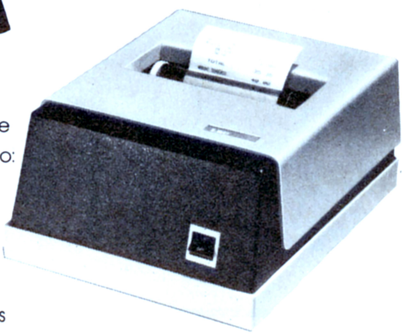

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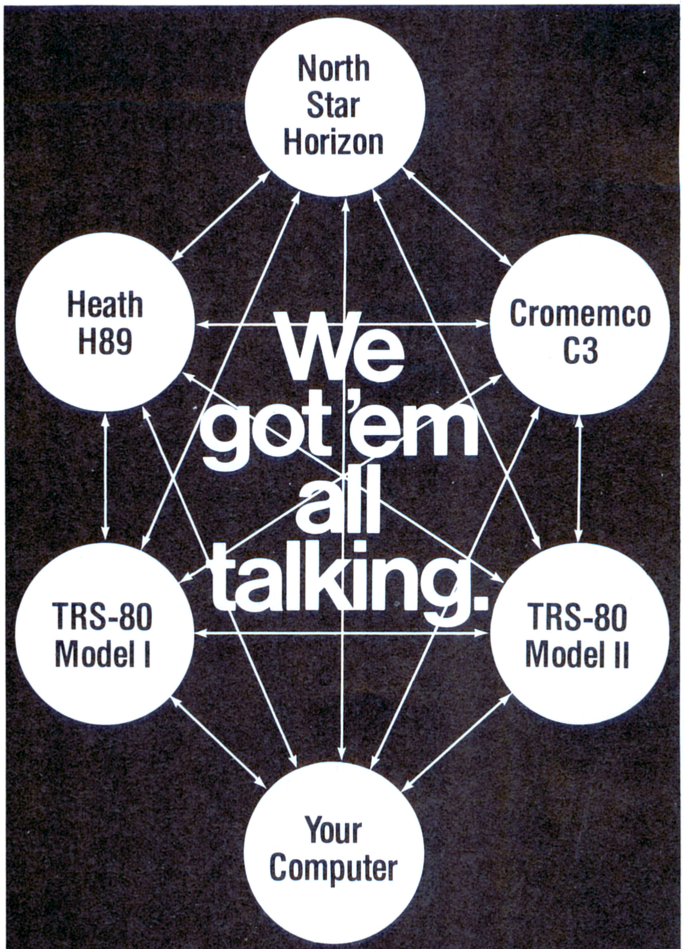

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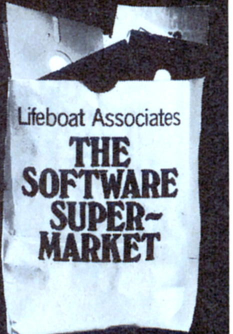

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June 16-20

Data Flow Concepts in Computer Language and Architecture, Massachusetts Institute of Technology (MIT), Cambridge MA. MIT's program will cover principles of data flow computer organization and programming language design and applications. Certain architectures will be covered and techniques will be discussed. Familiarity with languages and architecture is a prerequisite. The tuition is $750. Living arrangements can be made through the school. Contact the Office of the Summer Session, Room E19-356, MIT, Cambridge MA 02139.

June 17-19

Data Comm, Palais des Expositions, Geneva, SWITZERLAND. Data communications and distributed-data processing are the main themes of this conference and exhibition. Software development and tools, computer languages, managing data-communications systems, and definitions, concepts, and applications of data communications and distributed-data processing are some of the topics that will be covered in the conference.

For more information, contact Industrial and Scientific Conference Management Inc, 222 W Adams St, Suite 999, Chicago IL 60606.

June 18-21

Association for Computational Linguistics, University of Pennsylvania, Philadelphia PA. The meeting will cover theoretical and methodological problems of computational linguistics, speech acts, analysis of multisentence texts, dialogue, machine translation, and computational semantics. For further information contact Don Walker, Artificial Intelligence Center, SRI International, 333 Ravenswood Ave, Menlo Park CA 94025.

June 20-22

The Fifth Annual Computerfest, Franklin University, Columbus OH. Sponsored by the Midwest Affiliation of Computer Clubs, this is a gathering of interested hobbyists, professionals, and business-oriented computer users. Workshops and discussions are the main features of the conference. Contact James Crowley, 4008 Rickenbacker Ave, Columbus OH 43213.

JULY 1980

July 7-11

Computers and Related Products, Hyatt Regency Hotel, Seoul, KOREA. This show is limited to approximately forty firms for exhibition. For details, contact Robert Wallace, Rm 6015A, US Dept of Commerce, Industry and Trade Commission, Washington DC 20230.

July 14-16

Diagnostic Software: Planning and Design, Sheraton-Lexington Motor Inn, Lexington MA. The seminar is for design, test, and diagnostic engineers. Design examples, lectures, informal sessions, and programming are part of the course. The fee is $450. Contact Professor Donald French, Institute for Advanced Professional Studies, One Gateway Center, Newton MA 02158.

July 14-18

SIGGRAPH '80, Seattle Center, Seattle WA. Panel discussions and readings will be included in this conference. The topics will include graphic displays, animation/dynamics, cartography, input techniques, video and color hardware, and more. For general information, write to SIGGRAPH '80, POB 88203, Seattle WA 98188.

July 22-24

Microcomputer Show, Wembley Center, London, ENGLAND. New products will be exhibited, along with presentations of papers. For information contact TMAC, 680 Beach St, Suite 428, San Francisco CA 94109.■

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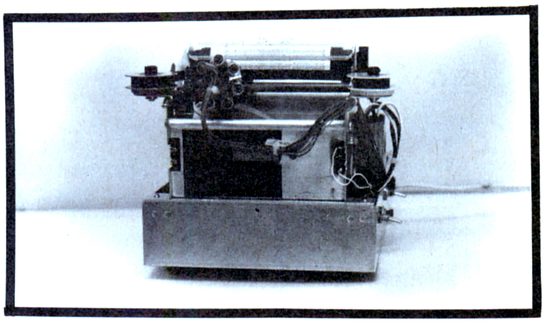

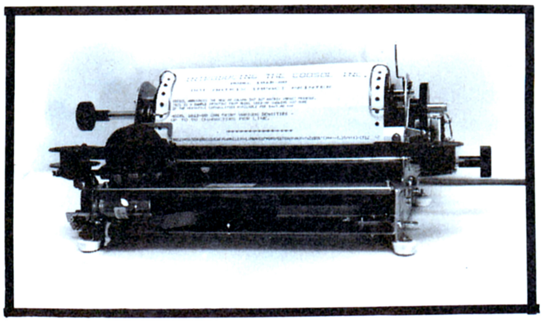

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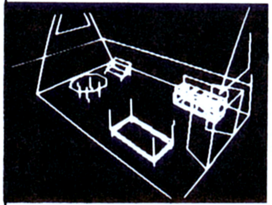

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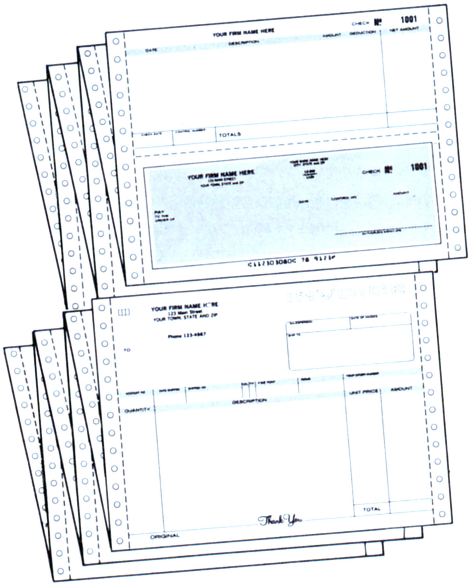

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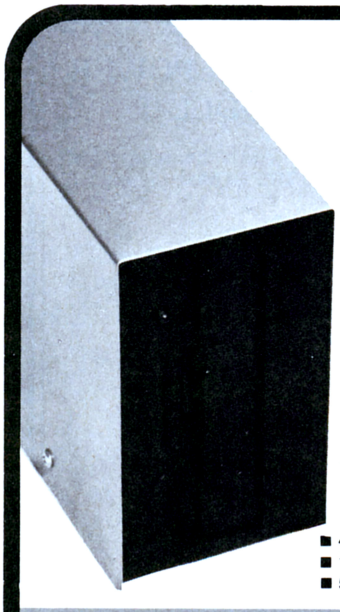

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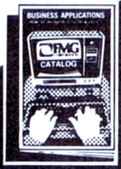

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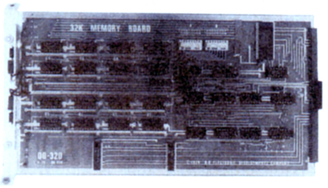

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Figure 1 shows the connection of the active error-checking and correcting apparatus between the computer and the peripheral data-storage device.

The theoretical development of error-trapping and correcting codes is largely due to the efforts of Richard W Hamming, a mathematician who first published on the subject in the *Bell System Technical Journal* early in 1950. (See reference 1.) Now, thirty years later, *Hamming codes* still represent one of the more practical approaches to the error-correcting problem.

A particularly important aspect of Hamming's work focused on his formulation of the concept of *code distance* (indicated by the letter D). This relates the uniqueness of (or "distance between") meaningful codes to the number of *simultaneous* errors (indicated by the Greek theta, θ) that can be detected and corrected.

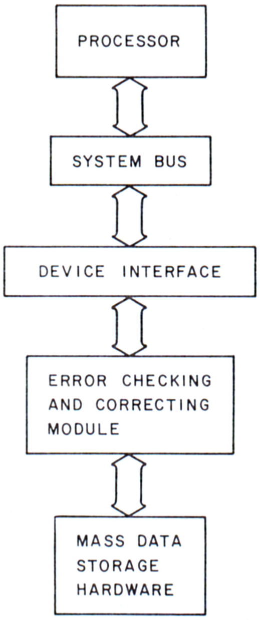
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Figure 1: *Block diagram showing interconnection of error-checking and correcting system with the computer.*

Definition of Hamming Distance

The Hamming distance between any two words is defined as the number of bit positions in which they differ. In terms of logical processes this is merely the total number of bits set to logic 1 following an exclusive-OR operation between the two words, as shown in figure 2. Simple binary coding has a Hamming distance of 1. This unitary distance is precisely the source of the problem, because any given code value appears to be as valid as any other.

Normally, as a processor receives binary data from a peripheral device, no mechanism is present which can correct a bit inversion. If a bit is read erroneously, it will either invalidate the check sum and cause an error trap, or it will be loaded into main memory without detection, thus propagating the error. It may or may not be a critical fault.

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2	0100
3	1000

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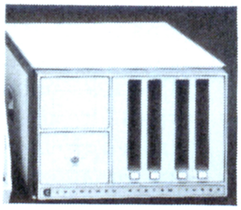

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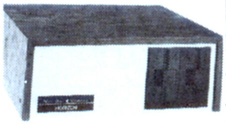

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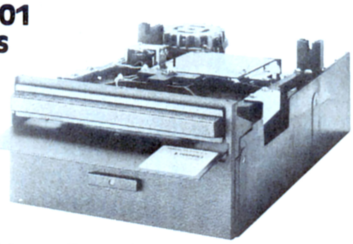

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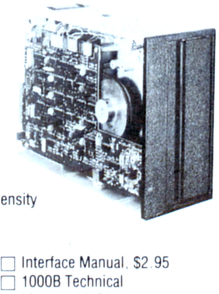

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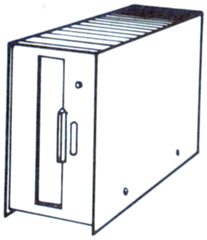

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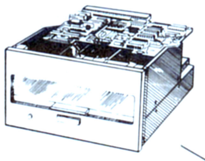

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```
01001111
11101001     }   10100110

00000000
00000001     }   00000001

00000000
11111110     }   11111110

01010101
10101010     }   11111111
```

Figure 2: *The logical exclusive-OR function produces the output bytes shown in the right column from the input bytes shown in the left column. For each bit, the output bit is a 1 if and only if one of the input bits is a 1.*

Hamming Distance (Minimum)	
1	code uniqueness
2	single-error detection
3	single-error correction
4	single-error correction/double-error detection
5	double-error correction

Table 1: *Minimum Hamming code distances necessary to obtain the listed properties in a particular coding scheme. Capabilities increase directly as Hamming distance increases (for small distances). Correction of an arbitrary number of errors requires a Hamming distance of at least twice the number of errors plus 1.*

ming distance of 2. It is impossible to invert a single bit position and create any one of the other three valid words.

Symbol	Encoded Form
3	1000
	↓
INVALID	1100

However, if a dual error occurred, the code's error-detection capability would fail:

Symbol	Encoded Form
3	1000
	⇊
2	0100

As indicated above, when the Hamming distance increases, the allowable number of simultaneous errors, θ, also rises. Errors can be trapped effectively as long as θ does not equal or exceed the Hamming distance minus 1 (D − 1). This should be clear, any sequence of (D − 1) errors will result in the generation of a meaningless code word if the distance between code words is given by D. No series of (D − 1) errors will produce a meaningful code.

Correcting Errors

Error-*correction* capability necessitates a larger Hamming distance, as shown in table 1. Any pattern of θ errors can be corrected if, and only if the Hamming distance D is greater than or equal to $(2\theta + 1)$. In this case, any received data word with θ errors differs from the transmitted, correct word in θ positions, but it also differs from all *other* meaningful words in at least $(2\theta + 1 - \theta)$, that is, $(\theta + 1)$ positions.

The erroneously received word therefore lies closer to the correct transmitted word than to any other possible word. Thus, it is possible to reconstruct the proper coding and recover the correct data word. To illustrate this point, the 4-bit code from the previous example does not meet the criterion of D greater than or equal to $(2\theta + 1)$, and is therefore uncorrectable. A single bit error in either of the two positions can lead to the same erroneous code:

Symbol	Encoded Form
3	1000
	↓
INVALID	1010
	↑
1	0010

Examination of the invalid code (1010) yields no information concerning what the correct pattern was initially. This meaningless value (1010)

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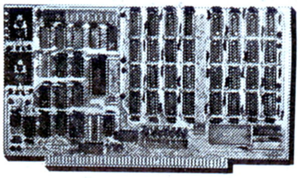

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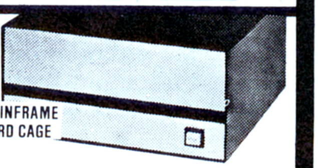

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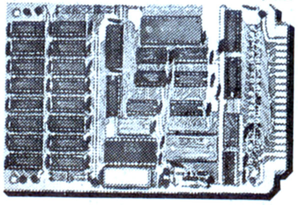

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could have been generated from an originally encoded 3 (pattern 1000), with an error in bit 1, or from an encoded 1 (pattern 0010) with an error in bit 3. Without any additional information, it is impossible to distinguish between these cases. Once an error occurs, although it can be trapped by searching for invalid codes, it cannot be corrected.

Now consider the correctable code:

Symbol	**Encoded Form**
0	00000
1	11101
2	11010
3	00111

Examination of this new code reveals a minimum Hamming distance (D) of 3 between the various states, permitting single error correction. (See table 1.) The inefficiency of this code is obvious; however it should be clear that any single error can be detected and *located* using this scheme.

Symbol	Binary Form	7-bit Encoded Form
00	0000	1110000
01	0001	1000001
02	0010	0100010
03	0011	0010011
04	0100	0000100
05	0101	0110101
06	0110	1010110
07	0111	1100111
08	1000	0011000
09	1001	0101001
10	1010	1001010
11	1011	1111011
12	1100	1101100
13	1101	1011101
14	1110	0111110
15	1111	0001111

Table 2: *Sixteen different logical entities or symbols can normally be represented by a 4-bit code. Use of a unique 7-bit encoding increases the Hamming distance to 3 and allows a single-bit error correction.*

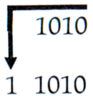
Symbol	**Encoded Form**
0	00000
	↓
INVALID	00001

The erroneous pattern could only be the result of encoding a 0 with an inversion in the least significant bit. Given the word 00001, the original, correct coding could be restored. This can be attributed to the fact that even the invalid, meaningless patterns display a limited uniqueness, and are directly traceable to specific *valid* codes subject to a small number of errors.

Uses of Parity

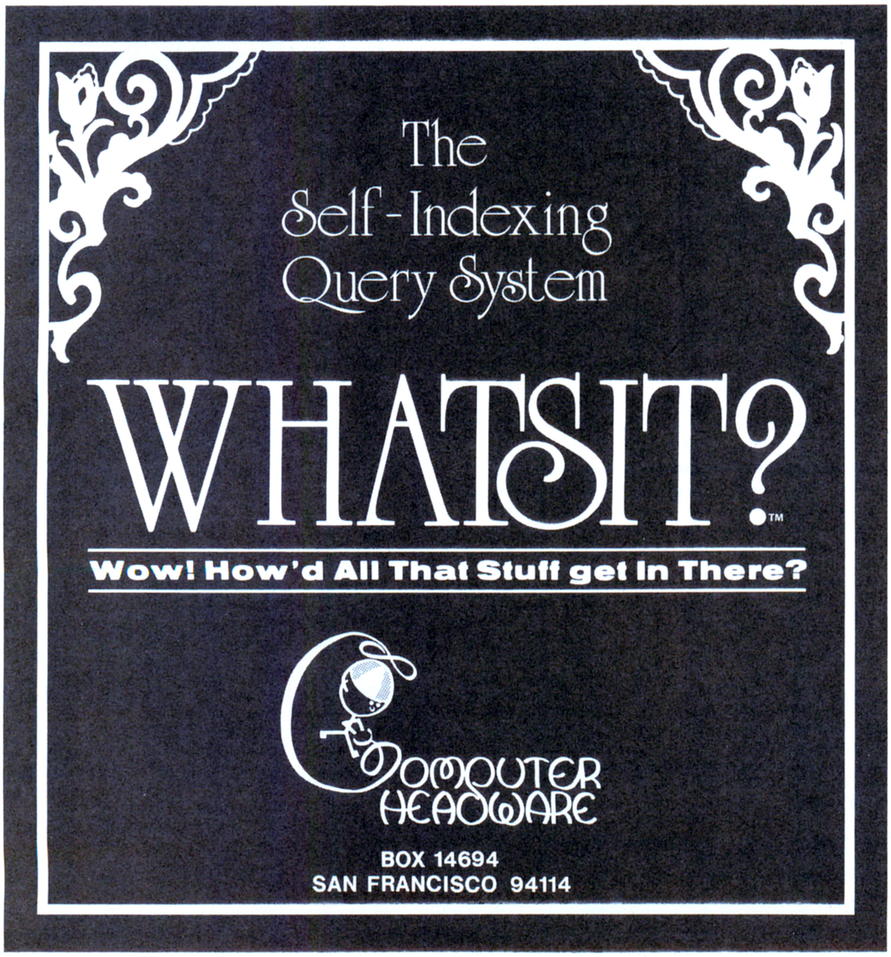
Clearly, coding efficiency is hampered as the Hamming distance is increased and as the requirements for trapping and correcting power are made more stringent. It becomes a matter of systematically generating a code that displays enough "correcting power" to handle data words of a useful length, without creating an excessive code-redundancy overhead. Here, the concept of *parity* plays an important role. Parity is established in a data word through the setting of an *additional* bit, such that the total number of bits set to logic 1 is either always odd or always even.

The operation of simple parity encoding and decoding is easy to understand. Assume, for example, that a data word 4 bits wide undergoes an odd-parity test across the entire word:



During encoding in this example, the fifth bit (the parity bit) is set to establish *odd* parity. Upon decoding, if the parity bit is included in an identical parity check, namely odd parity across the entire word (now 5 bits wide), the output of the parity test will be a logic 0.

If at some point between encoding and decoding, an error forces an inversion in a single bit (eg: with an error in bit 3, input to the decoder will be 10010), the odd-parity test will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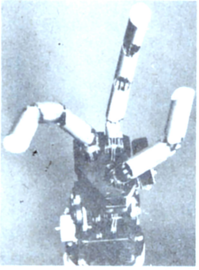

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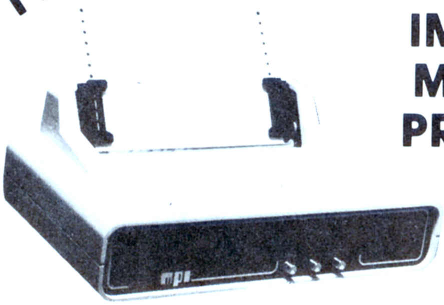

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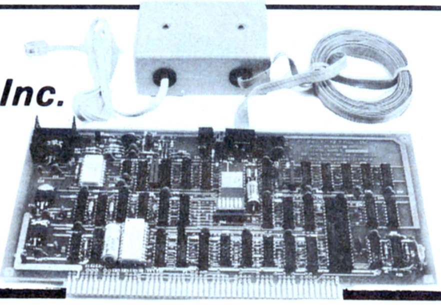

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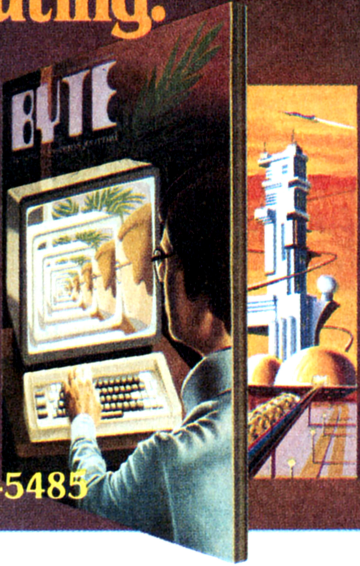

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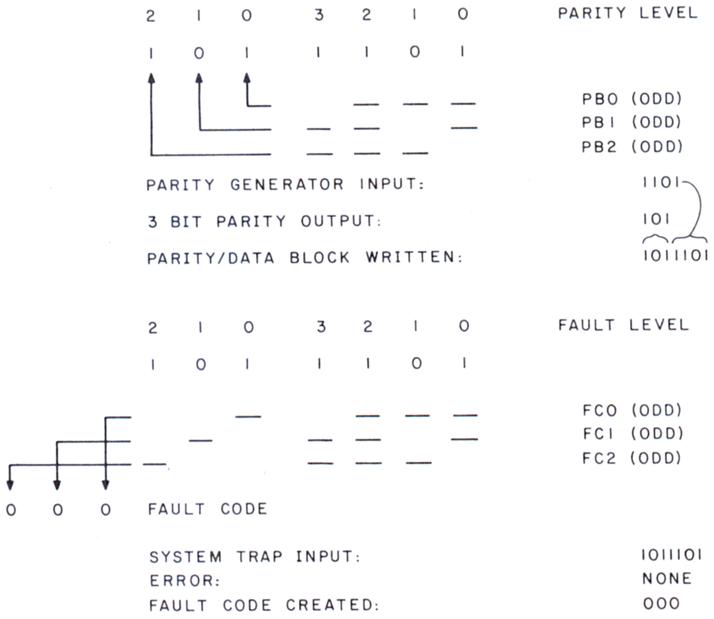

Figure 3: *Sixteen different logical states may be represented in a 7-bit code with a Hamming distance of 3. Single-bit errors may be detected and corrected. Encoding in 7 bits is accomplished by performing three distinct parity checks on 4 data bits. Table 4 shows the possible fault codes. The fault code of 000 indicates that no error was detected in decoding.*

fail and produce a logic 1 signifying an error.

Operation of Hamming Codes

Certainly this mechanism can be fooled by multiple errors, but it is possible to construct *multiple-level* parity checks which will trap a surprising number of errors. This is precisely how the Hamming codes operate. Fundamentally, Hamming's algorithm performs multiple-level parity generation on a data word at the data source. This parity code is then transmitted along with the data, and the entire code block (data plus parity code) is subsequently decoded under an analogous process. Any bit errors occurring during transmission will be detected.

Clearly, the efficiency of this error trap will approach 100% only in very simple cases. Several parameters have direct bearing on the trapping success: total word length N, number of data bits K, number of parity bits M ($M = N - K$). The ultimate goal, of course, is to realize the ideal where the quantity N/K approaches 1, and M is minimized without sacrificing trapping and correcting capability.

A 4-bit binary code is normally capable of representing sixteen different states with a Hamming distance equal to 1. Momentarily setting aside questions of efficiency, the same sixteen states can also be represented in a 7-bit code at triple the Hamming distance, as shown in table 2. Again, referring to table 1, a Hamming distance of 3 facilitates single-error correction. Encoding in 7 bits is accomplished by performing three distinct parity checks on the 4 data bits. Details of the three parity checks are summarized in table 3 and diagrammed in figure 3.

It should be understood that the actual encoded form of each symbol is irrelevant and need not be known. When no error is present, decoding of the 7-bit word will reset all three parity checks to logic 0, and will restore the data to its original form. The error-handling process is demonstrated in figure 4. With an error in the third data bit, the parity-decoding procedure flags a fault code of 110, which in table 4 is seen to correspond uniquely to an error in data position 3.

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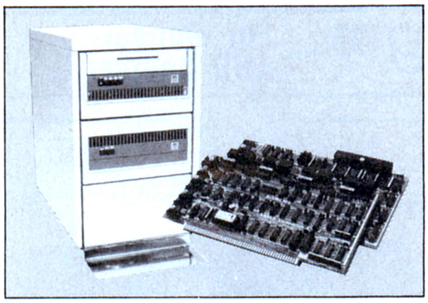

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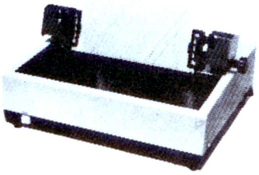

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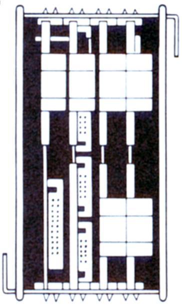

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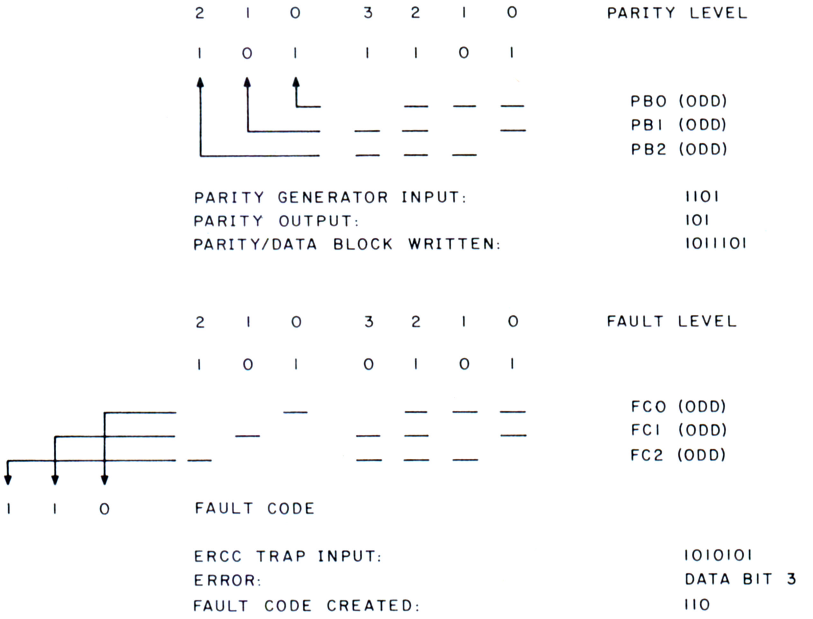
Admittedly, this does not constitute a true Hamming code, in the sense that the fault code does not display the binary form of the error-bit position within the word. This feature is convenient to implement for the shorter codes, but need not be attempted in the more comprehensive correction schemes where fault-code interpretation can be readily handled in a read-only memory.

Practicality of Use

An overhead of three parity flags for every 4 data bits is undesirable. These techniques become useful only for larger word lengths. Initially, performance increases as the data word length becomes longer, up to N = 31. It is possible to correct single-bit errors in words with 8 data bits and four additional parity flags, an overhead of 50%. Single-error correction of 16 bits requires five flags, an overhead of 32%.

In the case of an 8-bit system, an overhead of 50% may seem exorbitant, but it can pay off rapidly. Assuming that with correcting logic in operation, single errors are virtually nonexistent, it may well be possible to realize a decrease in loading time by a factor of 2, 5 or even 10. It is true that 1.5 times as many bits are being moved into and out of the storage medium, but if the data rate merely doubles, loading times will fall to


2 1 0 3 2 1 0
PARITY LEVEL
1 0 1 1 1 0 1
PB0 (ODD)
PB1 (ODD)
PB2 (ODD)
2 1 0 3 2 1 0
FAULT LEVEL
1 0 1 0 1 0 1
FC0 (ODD)
FC1 (ODD)
FC2 (ODD)
1 1 0
FAULT CODE

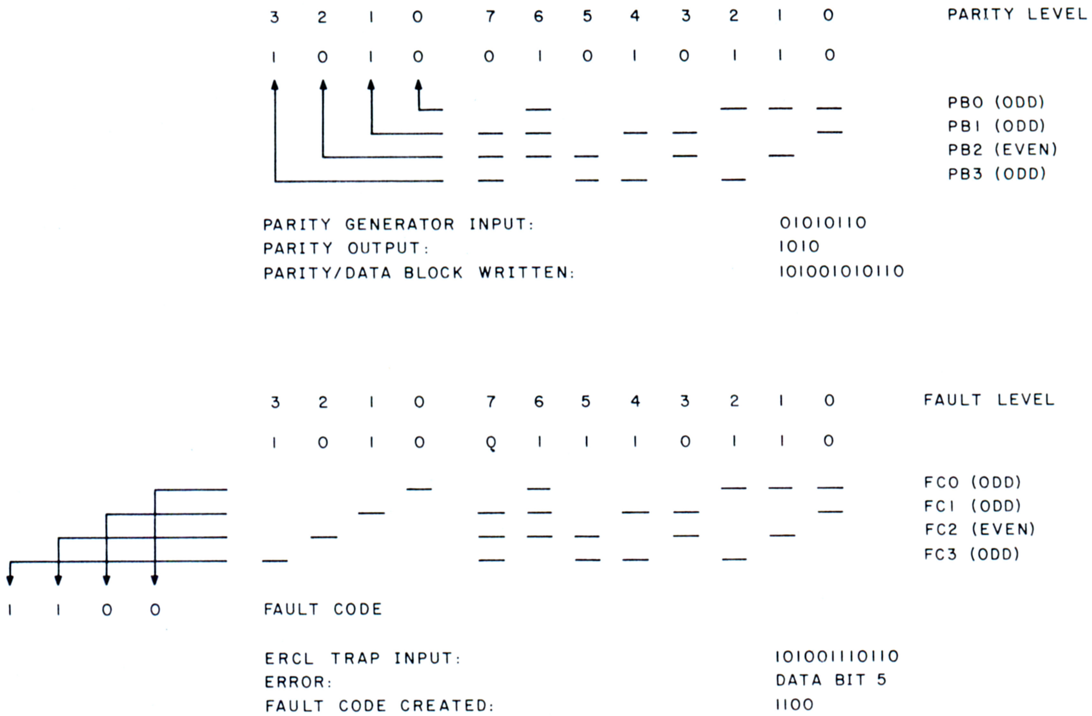
PARITY GENERATOR INPUT: 1101
PARITY OUTPUT: 101
PARITY/DATA BLOCK WRITTEN: 1011101

ERCC TRAP INPUT: 1010101
ERROR: DATA BIT 3
FAULT CODE CREATED: 110

Figure 4: *Another example of encoding and decoding data composed of 4 bits in a 7-bit word. In this case an error has been detected; the fault code of 110 indicates an error in data bit 3.*

Check Bit	Data Positions	
0	0,1,2	(odd)
1	0,2,3	(odd)
2	1,2,3	(odd)

Table 3: *Encoding 4-bit data into 7 bits is done by performing 3 distinct parity checks on the 4 data bits. Each of the 3 check bits corresponds to the parity value of the data positions shown here.*


3 2 1 0 7 6 5 4 3 2 1 0
PARITY LEVEL
1 0 1 0 0 1 0 1 0 1 1 0
PB0 (ODD)
PB1 (ODD)
PB2 (EVEN)
PB3 (ODD)
3 2 1 0 7 6 5 4 3 2 1 0
FAULT LEVEL
1 0 1 0 0 1 1 1 0 1 1 0
FC0 (ODD)
FC1 (ODD)
FC2 (EVEN)
FC3 (ODD)
1 1 0 0
FAULT CODE

PARITY GENERATOR INPUT: 01010110
PARITY OUTPUT: 1010
PARITY/DATA BLOCK WRITTEN: 101001010110

ERCL TRAP INPUT: 101001110110
ERROR: DATA BIT 5
FAULT CODE CREATED: 1100

Figure 5: *Encoding and decoding for data consisting of an 8-bit byte. Four bits are used for error checking; the possible fault codes are given in table 6.*

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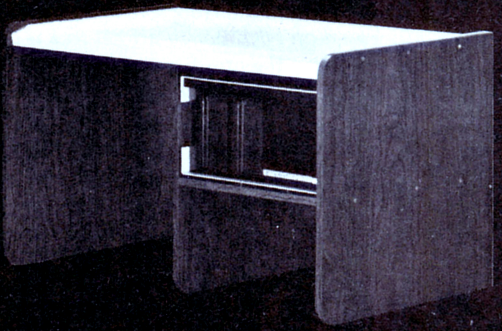

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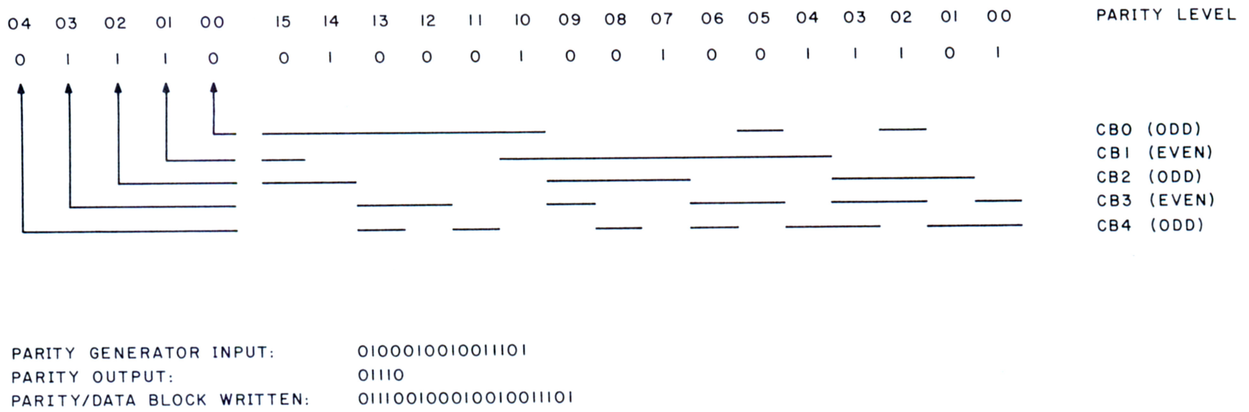
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PARITY LEVEL
0 1 1 1 0 0 1 0 0 0 1 0 0 1 0 0 1 1 1 0 1
CB0 (ODD)
CB1 (EVEN)
CB2 (ODD)
CB3 (EVEN)
CB4 (ODD)
PARITY GENERATOR INPUT: 0100010010011101
PARITY OUTPUT: 01110
PARITY/DATA BLOCK WRITTEN: 011100100010010011101

Figure 6a: *Encoding of 16-bit data using five bits for error checking; this results in a 21-bit data word being written to the peripheral device. Check bits based on even parity are set to 1 if there are an even number of 1s in the corresponding data-bit group; an odd-parity check bit is set to 1 if the number of 1s in its data-bit group is odd. This figure, figure 6b, and table 8 originally appeared in slightly different form in* Electronics *magazine, November 13, 1975, page 135. Copyright © McGraw-Hill Inc, 1975.*

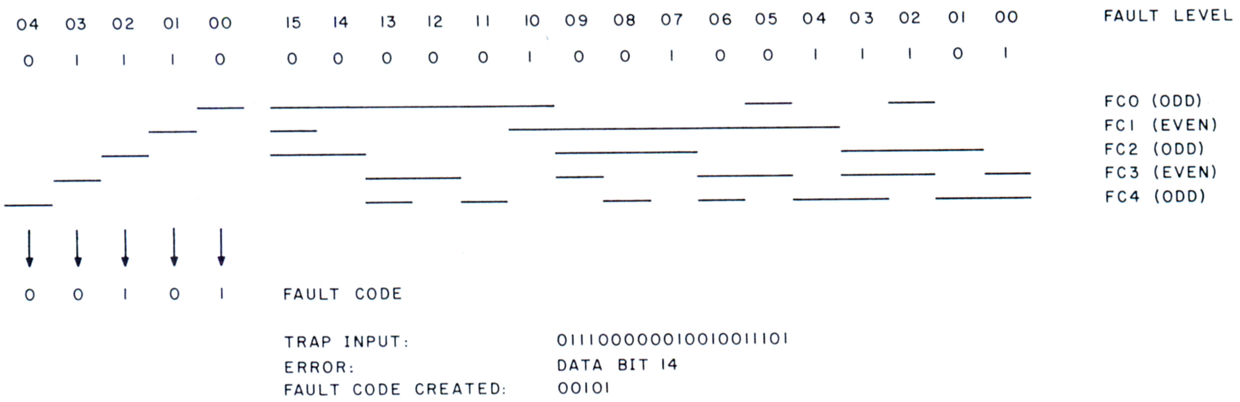
04 03 02 01 00 15 14 13 12 11 10 09 08 07 06 05 04 03 02 01 00
FAULT LEVEL
0 1 1 1 0 0 0 0 0 0 1 0 0 1 0 0 1 1 1 0 1
FC0 (ODD)
FC1 (EVEN)
FC2 (ODD)
FC3 (EVEN)
FC4 (ODD)
0 0 1 0 1
FAULT CODE
TRAP INPUT: 011100000010010011101
ERROR: DATA BIT 14
FAULT CODE CREATED: 00101

Figure 6b: *Decoding and checking the 16-bit data, 5-bit parity-check word from figure 6a. Bit 14 has been transmitted erroneously; therefore a fault code of 00101 (reading from check bit 04 to bit 00) is generated. A complete list of possible fault codes is given in table 8 (in reverse order, reading from check bit 00 to bit 04).*

Fault Code	Error
000	no error detected
001	check bit 0
010	check bit 1
011	data bit 0
100	check bit 2
101	data bit 1
110	data bit 3
111	data bit 2

Table 4: *Look-up table of fault codes used by the 4-bit into 7-bit encoding scheme. The fault code tells the error-correcting logic where the error has occurred.*

75% of the initial value. A ten-fold increase in data rate decreases loading time by 85%. Sixteen-bit systems are even better suited to the use of error checking and correcting systems (ERCC), though the majority of microprocessors in use today operate with an 8-bit data word.

Encoding for 8 and 16 bits is shown in figures 5 and 6. The detailed parity tests for these appear in tables 5 and 7 respectively. The fault-code look-up tables are shown as tables 6 and 8. This 16-bit system was developed by the Data General Corporation. It will correct single-bit errors throughout the entire word, and will reportedly trap an average of 97% of the multiple faults that occur. Eight-bit coding logic has been verified in macroassembler routines on a DECsystem 10 by my associate Stephen J Gross, who is now at Stanford University.

Error-Reducing Hardware

Hardware implementation utilizes standard 7400 series transistor-transistor logic (TTL). Schematic diagrams are shown in figures 7 and 8. Parity encoding and decoding is accomplished with 9-bit parity trees (using a 74180 parity generator/tester).

Check Bit	Data Positions	
0	0,1,2,6	(odd)
1	0,3,4,6,7	(odd)
2	1,3,5,6,7	(even)
3	2,4,5,7	(odd)

Table 5: *Encoding of 8-bit data requires the use of four parity bits to allow single-bit error correction. The correspondence of each check bit to specific bits within the 8-bit data byte is shown here.*

Worst-case data path for both 8-bit and 16-bit error checking and correcting amounts to about 120 ns delay. Certainly, this interval is short enough to prevent it from imposing any constraint at even unusually high data-transfer rates. It should be clear that when handling errors, operation

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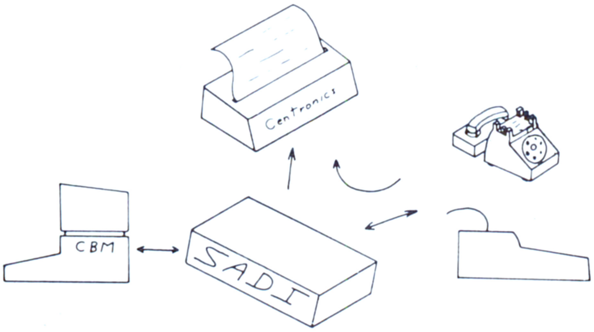

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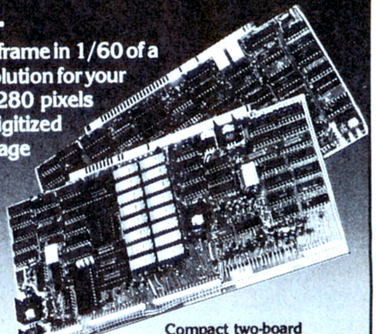

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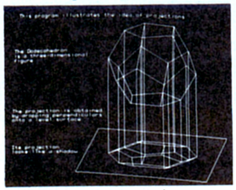

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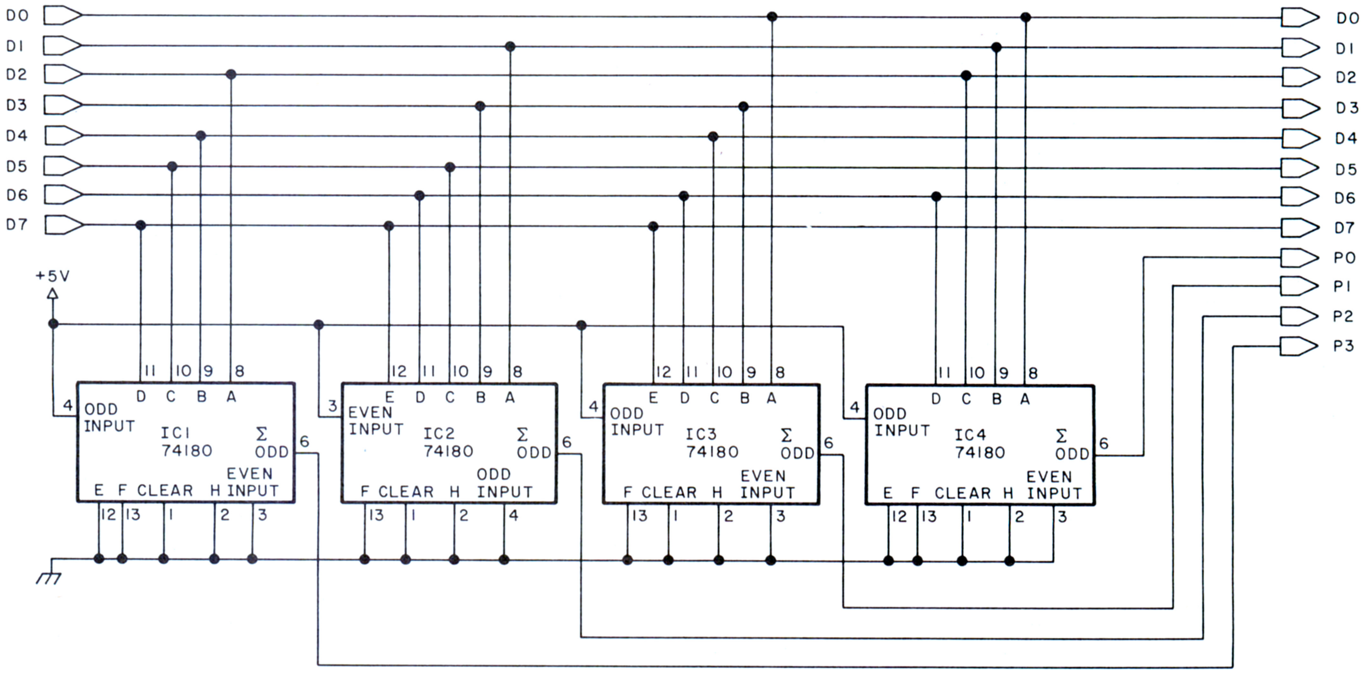
D0
D1
D2
D3
D4
D5
D6
D7
+5V
ODD INPUT
IC1 74180
D C B A
Σ ODD
E F CLEAR H EVEN INPUT
EVEN INPUT
IC2 74180
E D C B A
F CLEAR H ODD INPUT
ODD INPUT
IC3 74180
E D C B A
F CLEAR H EVEN INPUT
ODD INPUT
IC4 74180
D C B A
E F CLEAR H EVEN INPUT
P0
P1
P2
P3

Figure 7a: *Schematic diagram of electronic logic that encodes 8-bit data. Unused input pins on the 74180 parity-generator and tester devices are connected to ground.*

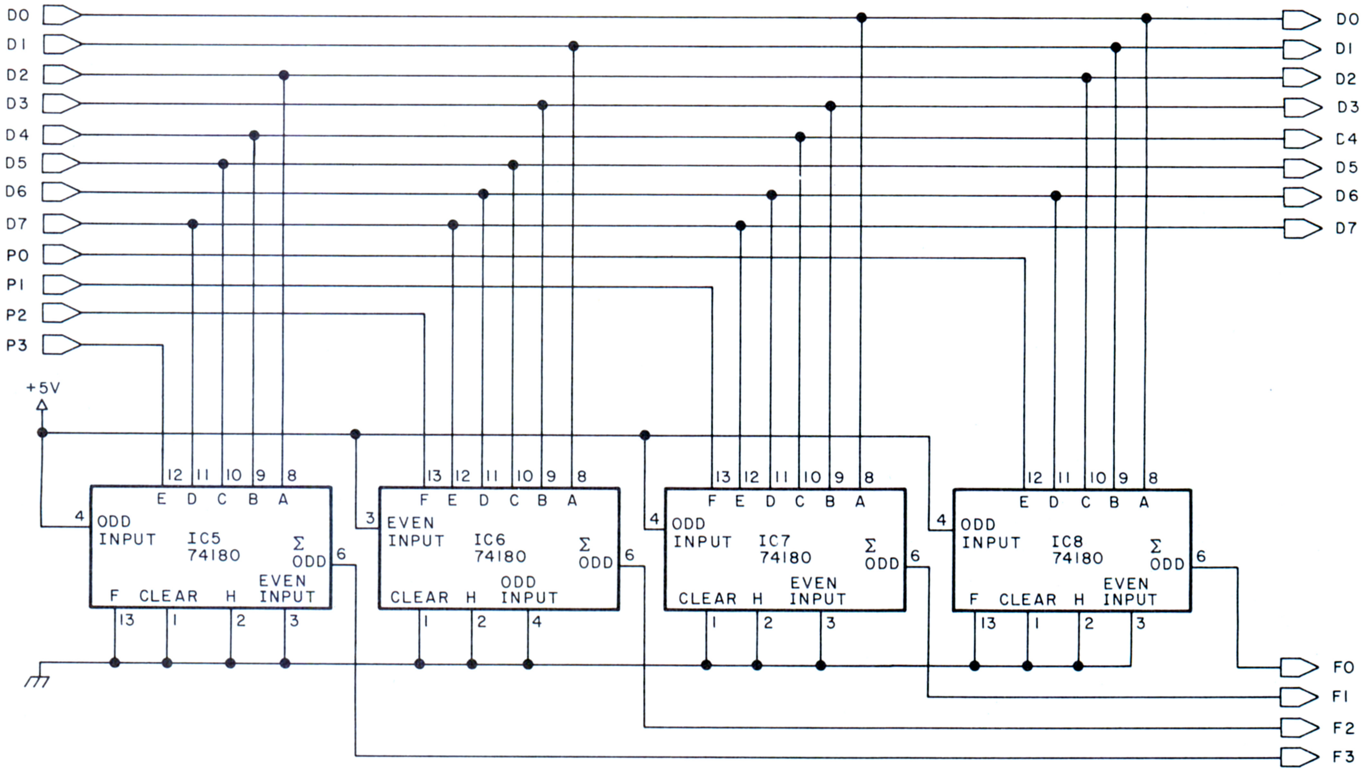
D0
D1
D2
D3
D4
D5
D6
D7
P0
P1
P2
P3
+5V
ODD INPUT
IC5 74180
E D C B A
Σ ODD
F CLEAR H EVEN INPUT
EVEN INPUT
IC6 74180
F E D C B A
CLEAR H ODD INPUT
ODD INPUT
IC7 74180
F E D C B A
CLEAR H EVEN INPUT
ODD INPUT
IC8 74180
E D C B A
F CLEAR H EVEN INPUT
F0
F1
F2
F3

Figure 7b: *Schematic diagram of circuit for trapping errors in the 8-bit data encoded by the circuit in figure 7a. The 12-bit word received from the peripheral device is separated into 8 bits of meaningful data and 4 bits of parity-checking data. Unused inputs on the 74180s are grounded.*

of the error checking and correcting apparatus is rapid enough to make it entirely transparent to the processor and the system bus.

Though the underlying theory requires the writing of additional parity bits, the generation and interpretation of these flags are contained entirely within the error-processing system. (See figure 9.) The parity bits do not appear on the bus and are not seen by the processor; therefore no interface modification is necessary. Additional data-transfer logic is required to deal with the parity bits. The circuits in figures 7 and 8 create parallel data which must undergo a

Text continued on page 274

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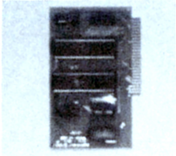

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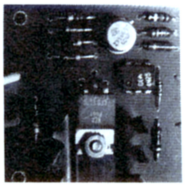

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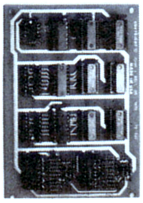

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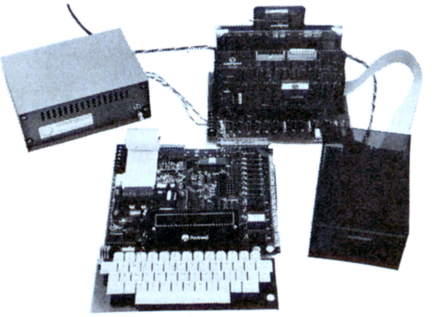

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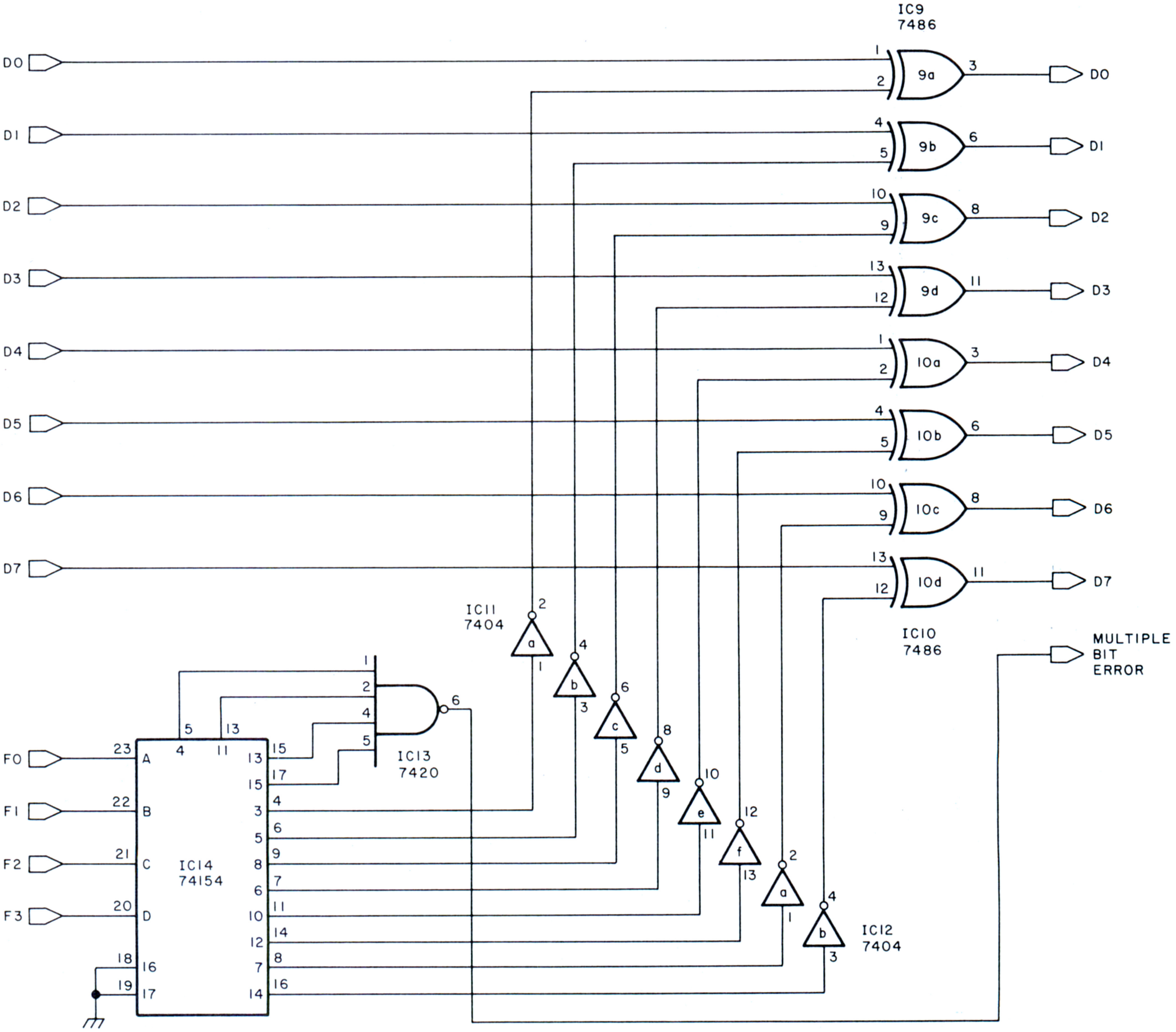
IC9
7486
D0
D1
D2
D3
D4
D5
D6
D7
9a
9b
9c
9d
10a
10b
10c
10d
IC10
7486
MULTIPLE
BIT
ERROR
IC11
7404
IC12
7404
IC13
7420
IC14
74154
F0
F1
F2
F3
A
B
C
D

Figure 7c: *Schematic diagram of the circuit which corrects single-bit errors trapped by the circuit of figure 7b. Multiple-bit errors are made known to the processor, but cannot be corrected using this scheme.*

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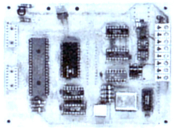

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*Sort timings shown below are nominal times. Times will vary based on sort and system configurations. Nominal times based on Mod I 48K 4-drive configuration, 64 byte records, and 5 sort keys.

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SORT	16K	33
SORT	32K	49
SORT	85K	173
SORT	170K	445

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Fault Code	Error
0000	no error detected
0001	check bit 0
0010	check bit 1
0011	data bit 0
0100	check bit 2 *
0101	data bit 1
0110	data bit 3
0111	data bit 6
1000	check bit 3
1001	data bit 2
1010	data bit 4
1011	all data and parity set to logic 0
1100	data bit 5
1101	multi bit error
1110	data bit 7
1111	multi bit error

Table 6: *Look-up table of fault codes used by the 8-bit to 12-bit encoding scheme. Setting of the check-bit-2 fault code (indicated by an asterisk) shows that all data and parity bits are set to logic 1.*

Check Bit	Data Positions	
0	2,5,10,11,12,13,14,15	(odd)
1	4,5,6,7,8,9,10,15	(even)
2	1,2,3,7,8,9,14,15	(odd)
3	0,2,3,5,6,9,12,13	(even)
4	0,1,3,4,6,8,11,13	(odd)

Table 7: *The 16-bit encoding scheme uses 5 parity bits that enable single-bit error correction. Each parity-check bit performs its check operation upon the data-bit positions shown here.*

Fault Code	Error
00000	no error detected
00001	error in check bit 4
00010	error in check bit 3
00011	error in data bit 0
00100	error in check bit 2
00101	error in data bit 1
00110	multiple-bit error
00111	error in data bit 3
01000	error in check bit 1
01001	error in data bit 4
01010	all data and parity set to logic 1
01011	error in data bit 6
01100	error in data bit 7
01101	error in data bit 8
01110	error in data bit 9
01111	multiple-bit error
10000	error in check bit 0
10001	error in data bit 11
10010	error in data bit 12
10011	error in data bit 13
10100	error in data bit 14
10101	all data and parity set to logic 0
10110	error in data bit 2
10111	multiple-bit error
11000	error in data bit 10
11001	multiple-bit error
11010	error in data bit 5
11011	multiple-bit error
11100	error in data bit 15
11101	multiple-bit error
11110	multiple-bit error
11111	multiple-bit error

Table 8: *Look-up table of fault codes used by the 16-bit to 21-bit encoding scheme. The codes are shown here in order from check bit 00 to bit 04, reversed from the representation in figure 6.*

Address Input	Data Output							
	7	6	5	4	3	2	1	0
00000	0	0	0	1	0	0	0	0
00001	0	1	0	1	0	0	0	0
00010	0	1	0	1	0	0	0	0
00011	0	0	0	0	0	0	0	0
00100	0	1	0	1	0	0	0	0
00101	0	0	0	0	0	0	0	1
00110	0	0	1	1	0	0	0	0
00111	0	0	0	0	0	0	1	1
01000	0	1	0	1	0	0	0	0
01001	0	0	0	0	0	1	0	0
01010	1	1	0	1	0	0	0	0
01011	0	0	0	0	0	1	1	0
01100	0	0	0	0	0	1	1	1
01101	0	0	0	0	1	0	0	0
01110	0	0	0	0	1	0	0	1
01111	0	0	1	1	0	0	0	0
10000	0	1	0	1	0	0	0	0
10001	0	0	0	0	1	0	1	1
10010	0	0	0	0	1	1	0	0
10011	0	0	0	0	1	1	0	1
10100	0	0	0	0	1	1	1	0
10101	1	0	1	1	0	0	0	0
10110	0	0	0	0	0	0	1	0
10111	0	0	1	1	0	0	0	0
11000	0	0	0	0	1	0	1	0
11001	0	0	1	1	0	0	0	0
11010	0	0	0	0	0	1	0	1
11011	0	0	1	1	0	0	0	0
11100	0	0	0	0	1	1	1	1
11101	0	0	1	1	0	0	0	0
11110	0	0	1	1	0	0	0	0
11111	0	0	1	1	0	0	0	0

Table 9: *Truth table which is programmed into a programmable read-only memory for use in the electronic circuit of the 16-bit error-checking and correcting system.*

Number	Type	+5 V	GND
IC1	74180	14	7
IC2	74180	14	7
IC3	74180	14	7
IC4	74180	14	7
IC5	74180	14	7
IC6	74180	14	7
IC7	74180	14	7
IC8	74180	14	7
IC9	7486	14	7
IC10	7486	14	7
IC11	7404	14	7
IC12	7404	14	7
IC13	7420	14	7
IC14	74154	24	12
IC15	74180	14	7
IC16	74180	14	7
IC17	74180	14	7
IC18	74180	14	7
IC19	74180	14	7
IC20	7404	14	7
IC21	74180	14	7
IC22	74180	14	7
IC23	74180	14	7
IC24	74180	14	7
IC25	74180	14	7
IC26	7488	16	8
IC27	74154	24	12
IC28	7404	14	7
IC29	7404	14	7
IC30	7404	14	7
IC31	7486	14	7
IC32	7486	14	7
IC33	7486	14	7
IC34	7486	14	7

Table 10: *Power supply connections for integrated circuits used in electronic logic described in this article.*

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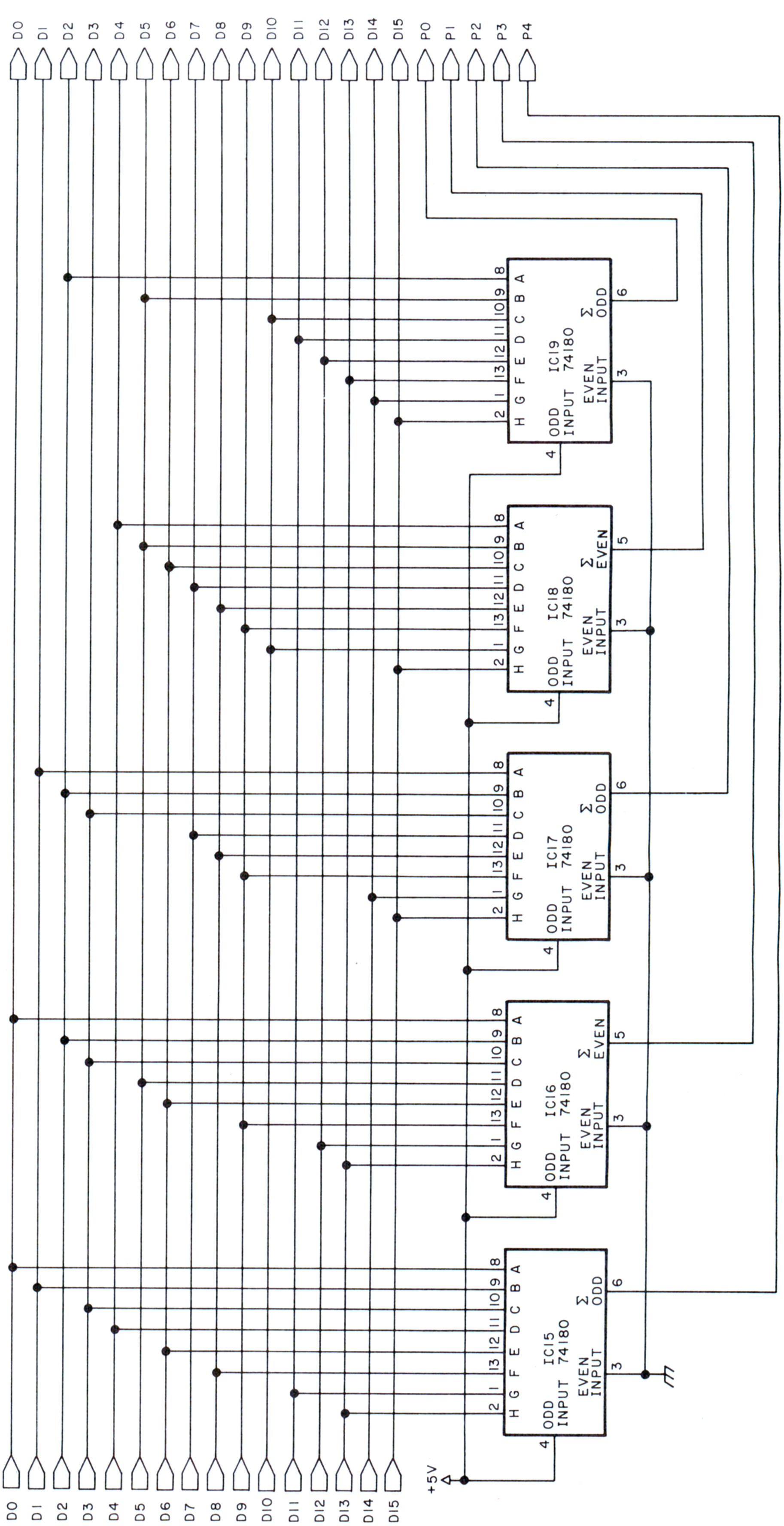

Figure 8a: *Schematic diagram of the circuit to encode 16-bit data into 21-bit words containing 5 parity bits.*

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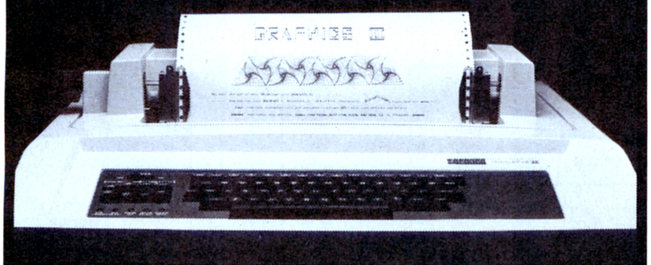

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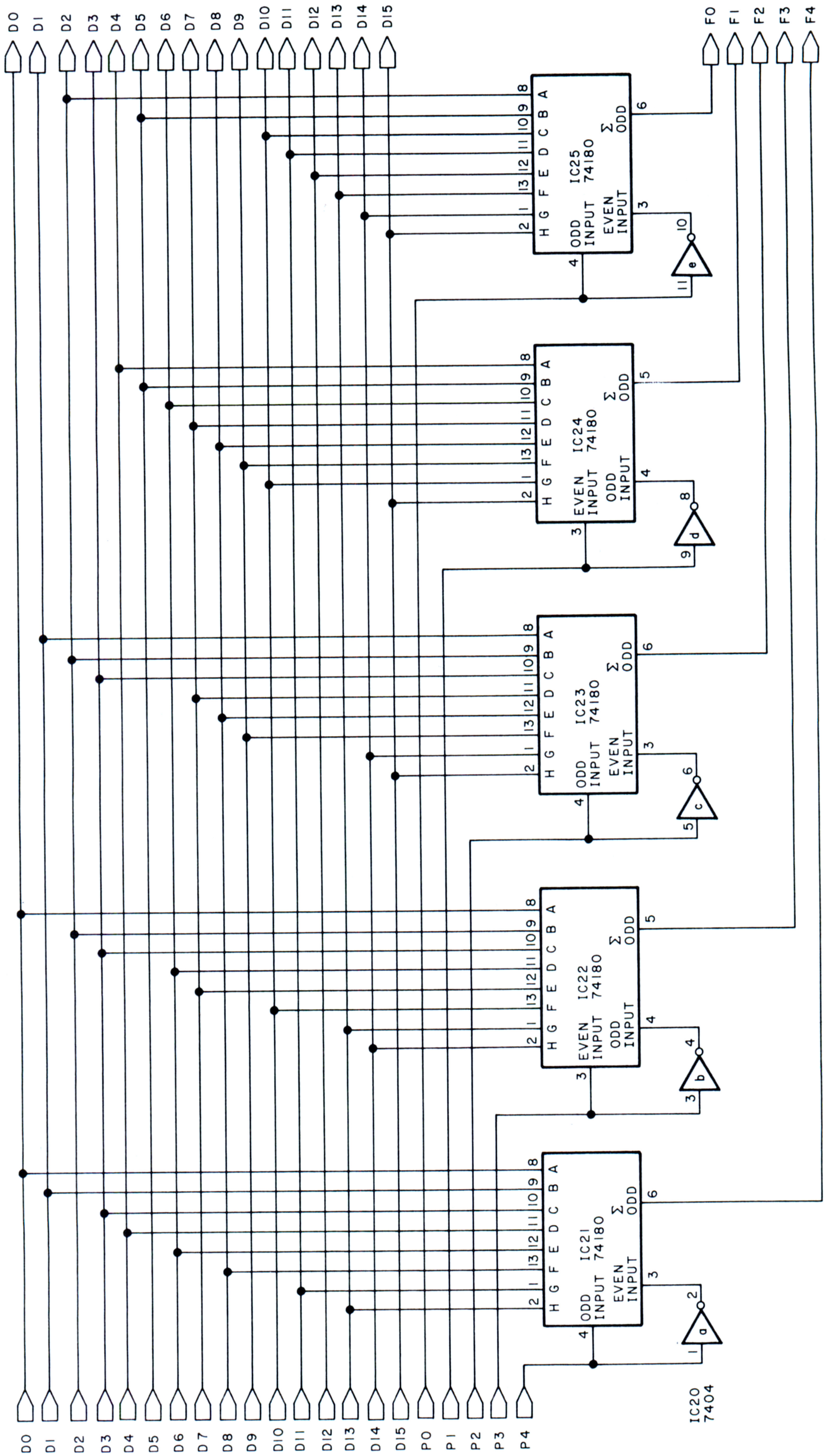

D0 D1 D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13 D14 D15
F0 F1 F2 F3 F4
P0 P1 P2 P3 P4
IC25 74180
IC24 74180
IC23 74180
IC22 74180
IC21 74180
IC20 7404
H G F E D C B A
2 1 13 12 11 10 9 8
ODD INPUT
EVEN INPUT
Σ ODD
a b c d e

Figure 8b: *Schematic diagram of the circuit which traps errors from the encoded 16-bit data. Five error-detecting bits are sent to the error-correcting circuit of figure 8c.*

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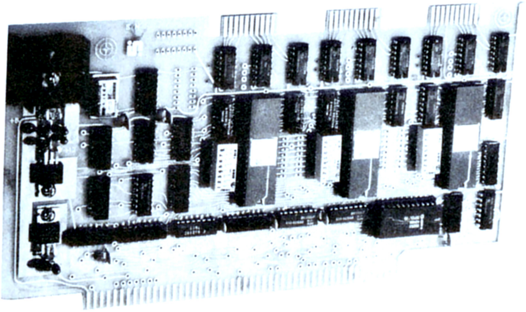

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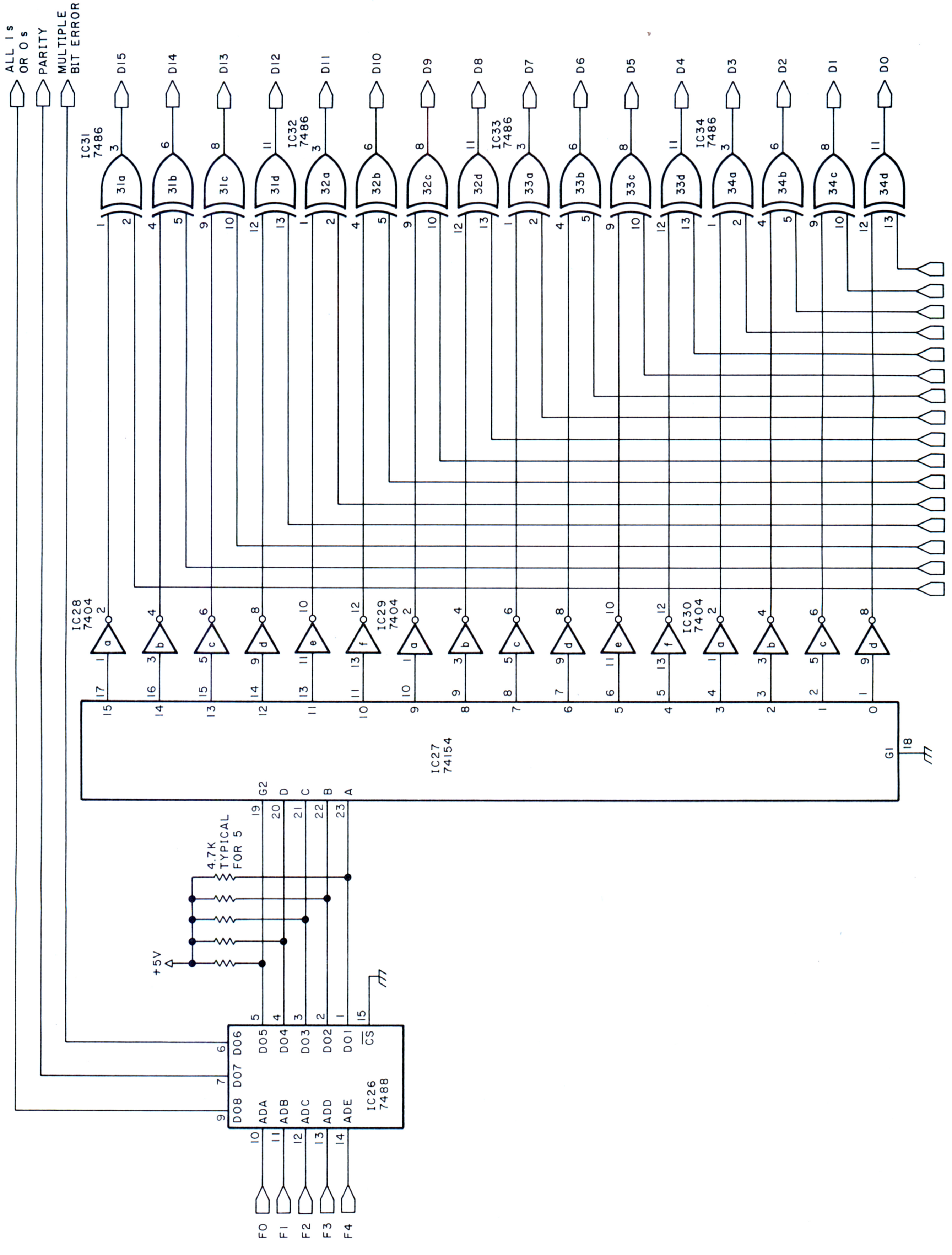
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PARITY
MULTIPLE BIT ERROR
D15
D14
D13
D12
D11
D10
D9
D8
D7
D6
D5
D4
D3
D2
D1
D0
IC31 7486
IC32 7486
IC33 7486
IC34 7486
31a
31b
31c
31d
32a
32b
32c
32d
33a
33b
33c
33d
34a
34b
34c
34d
IC28 7404
IC29 7404
IC30 7404
IC27 74154
G1
G2
A
B
C
D
4.7K TYPICAL FOR 5
+5V
IC26 7488
DO1
DO2
DO3
DO4
DO5
DO6
DO7
DO8
CS
ADA
ADB
ADC
ADD
ADE
F0
F1
F2
F3
F4

Figure 8c: *Schematic diagram of electronic logic that corrects errors in 16-bit data.*

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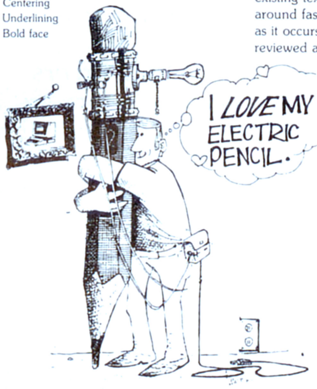
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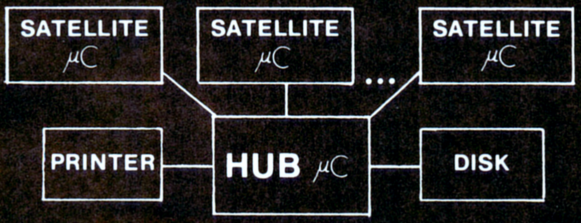

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Text continued from page 262:

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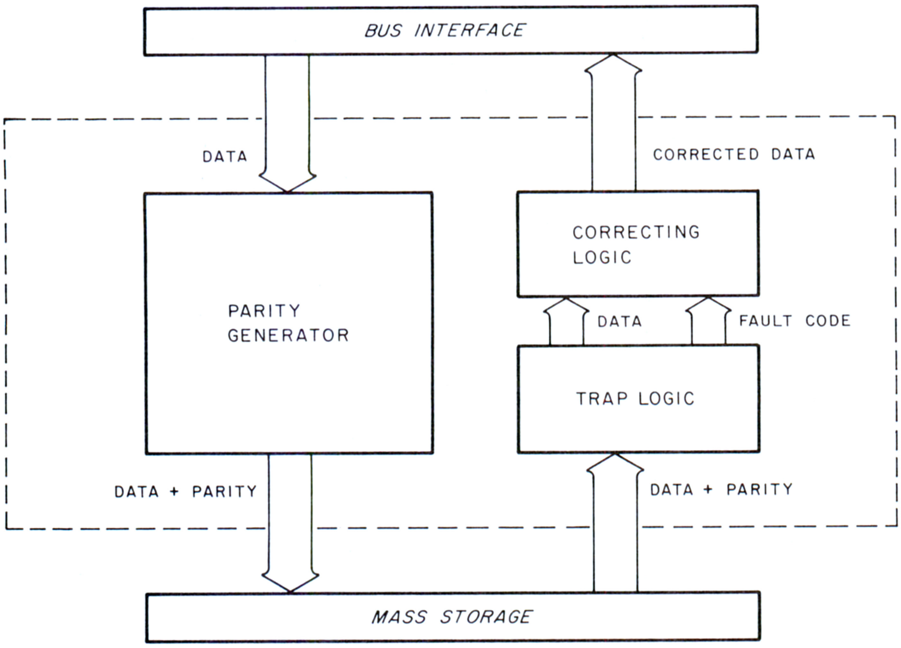

Figure 9: *Block diagram of data flow through the error-checking and correcting system. The extra parity bits are never seen by the processor, and make the system transparent from the point of view of the system bus.*

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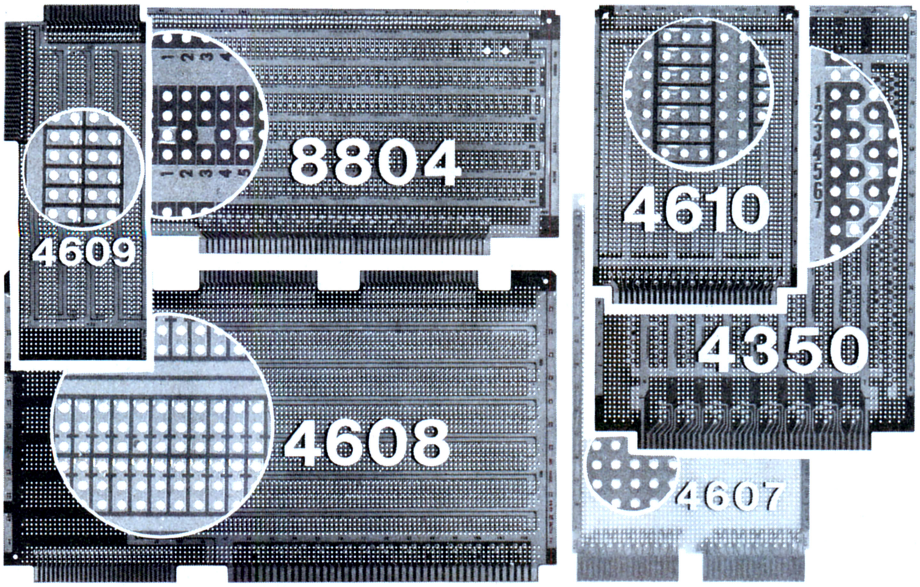

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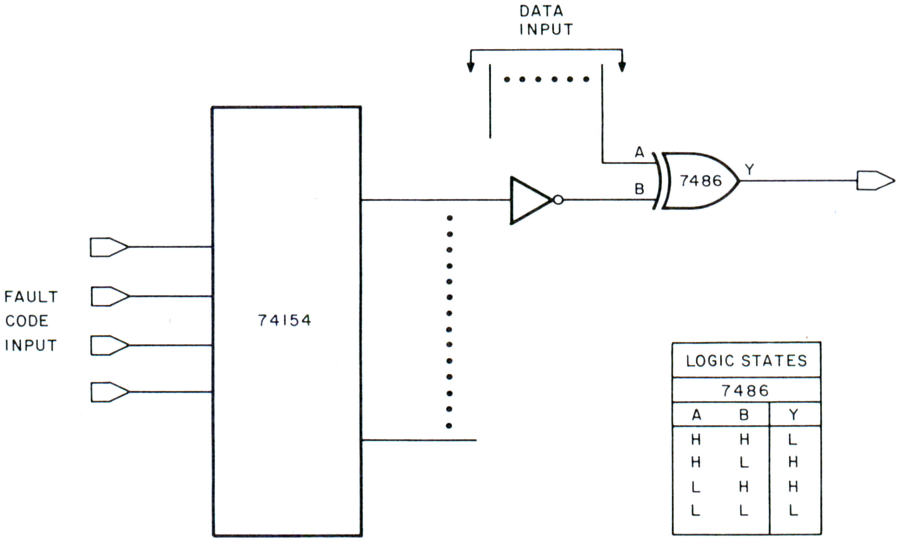
loader program can either abort the data transfer immediately, initiate a second read attempt from the last record, or display an error message on the computer terminal prompting direct operator intervention.



LOGIC STATES		
7486		
A	B	Y
H	H	L
H	L	H
L	H	H
L	L	L

Figure 10: *Detail of the error-correcting logic. Error correction is achieved by loading a binary pointer into a 4-to-16 line demultiplexer that flags the proper bit line and corrects the fault with an exclusive-OR inversion. Eight-bit systems may load the fault code directly into the demultiplexer and avoid the use of a read-only memory.*

Theoretical Advances

As reviewed by Peterson and Weldon, the Hamming algorithm falls in the category of *cyclic codes*. (See reference 3.) In cyclic codes, executing a one-unit right-shift operation on any symbol in the complete code set will produce a binary bit pattern identical to that of one of the *other* members of the code set. Since Hamming's initial publication, an extensive array of cyclic codes has been derived. Perhaps the best known are the Bose-Chaudhuri-Hocquenghem (BCH) codes, which are related to the Hamming algorithm.

The BCH codes actually represent a generalized expansion that is particularly suited to coping with multiple-bit errors. None of these newer solutions offer major advantage over the basic Hamming check when correcting an 8-bit data word. Several mathematical difficulties are encountered when attempting to derive more effective encoding procedures. Not only is word length relatively short in these systems, but it can be shown that code redundancy overhead can be minimized to a tolerable level in only a small number of cases.

The alternative method, which is not unreasonable, would be to encode and decode entire data blocks, as opposed to individual data words. This would take advantage of the increased coding efficiency found for the longer codes, but would probably require a software implementation to minimize hardware design and expense. Such an approach would certainly increase system reliability, but it would defeat the purpose of increasing the speed and efficiency of data transfer to and from mass storage, since the processor would spend considerable time encoding and decoding the parity and data blocks before and after each data transfer.■

References

1. Hamming, R W, "Error Detecting and Error Correcting Codes," *Bell System Technical Journal*, Volume 26 Number 2 pages 147 thru 160, American Telephone and Telegraph Company, 1950.
2. West, J T, "Product Development Profile: Data General Corporation," *Electronics* Volume 48 Number 23 pages 130 thru 136, November 13, 1975.
3. Peterson, W Wesley and E J Weldon Jr, *Error-Correcting Codes*, Second Edition, MIT Press, Cambridge 1972.
4. Sellers, F, Hsiao, M Bearnson, L, *Error Detecting Logic for Digital Computers*, IBM Corporation Systems Development Division, McGraw-Hill.

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2.2	Z80	8″
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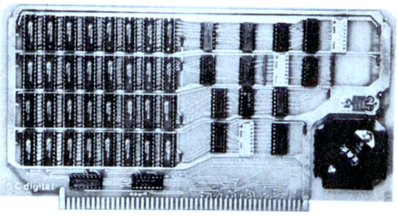

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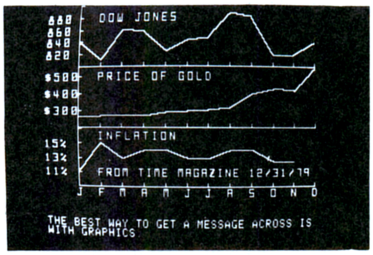

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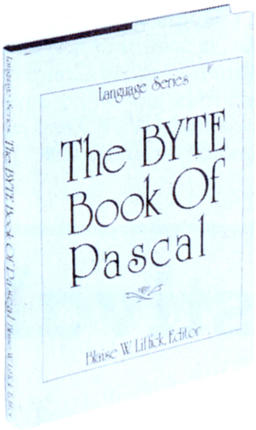

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The NCC:
New Emphasis on Personal Computing

What's happening in personal computing? The American Federation of Information Processing Societies, Inc (AFIPS) is banking that you'll find out at the National Computer Conference's Personal Computing Festival, to be held on May 20-22 in Anaheim, California at the Anaheim Convention Center. In the 3 years that personal computing has had a separate exhibit area at the NCC, the number of exhibitors has increased from 76 to 154. Over 20% of those who came to the NCC last year registered specifically for the Personal Computing Festival, and over half of the 60,000 plus attendees visited the Festival.

The booming show-attendance figures reflect the fast growth of the personal-computing industry as a whole. Highlights include the Apple Computer Company's expectations to triple its sales by the end of 1980. Commodore International computer sales may increase by a factor of 2 during the first quarter of 1980, and Radio Shack expects similar increases. According to industry estimates, the market value of personal-computer software sold in 1980 could surpass $150 million.

Judging from the attendance at last March's West Coast Computer Faire in San Francisco (approximately 20,000), there is an ever-increasing interest in personal computing among a wide variety of people. We expect to see a trend toward more sophisticated software at the 1980 NCC Personal Computing Festival. There will be a flood of new Pascal packages, new simulation programs, the appearance of new Forth software (look for the special section on the Forth language in the August 1980 BYTE), as well as intriguing new hardware like Microsoft's new Z80 processor circuit card for the Apple computer that allows Apple owners to use programs written to run under Digital Research Corporation's CP/M operating system. Word-processing and small-business software are two other rapidly growing areas that will be well represented at the conference.

Will some major consumer electronics companies enter the personal computer market? Is there a move toward some standardization in the microcomputer industry? Will Japanese companies make any major moves into personal computing? [Nippon Electric Company (NEC) is rumored to be unveiling a new computer at the show]. We'll keep our eyes open at the show to find out!■

Personal Computing Festival
Preliminary List of Exhibitors

ABC Computer Inc
American Word Processing Co
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Applied Digital Data Systems Inc
Artec Electronics Inc
Atari

BASF Systems
Benwill Publishing Corp
BYTE Publications Inc

California Computer Systems
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Hewlett-Packard Co

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International Memories Inc (IMI)

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Microcomputer Technology Inc
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NCC Personal Computing Festival

May 20-22, Disneyland Hotel

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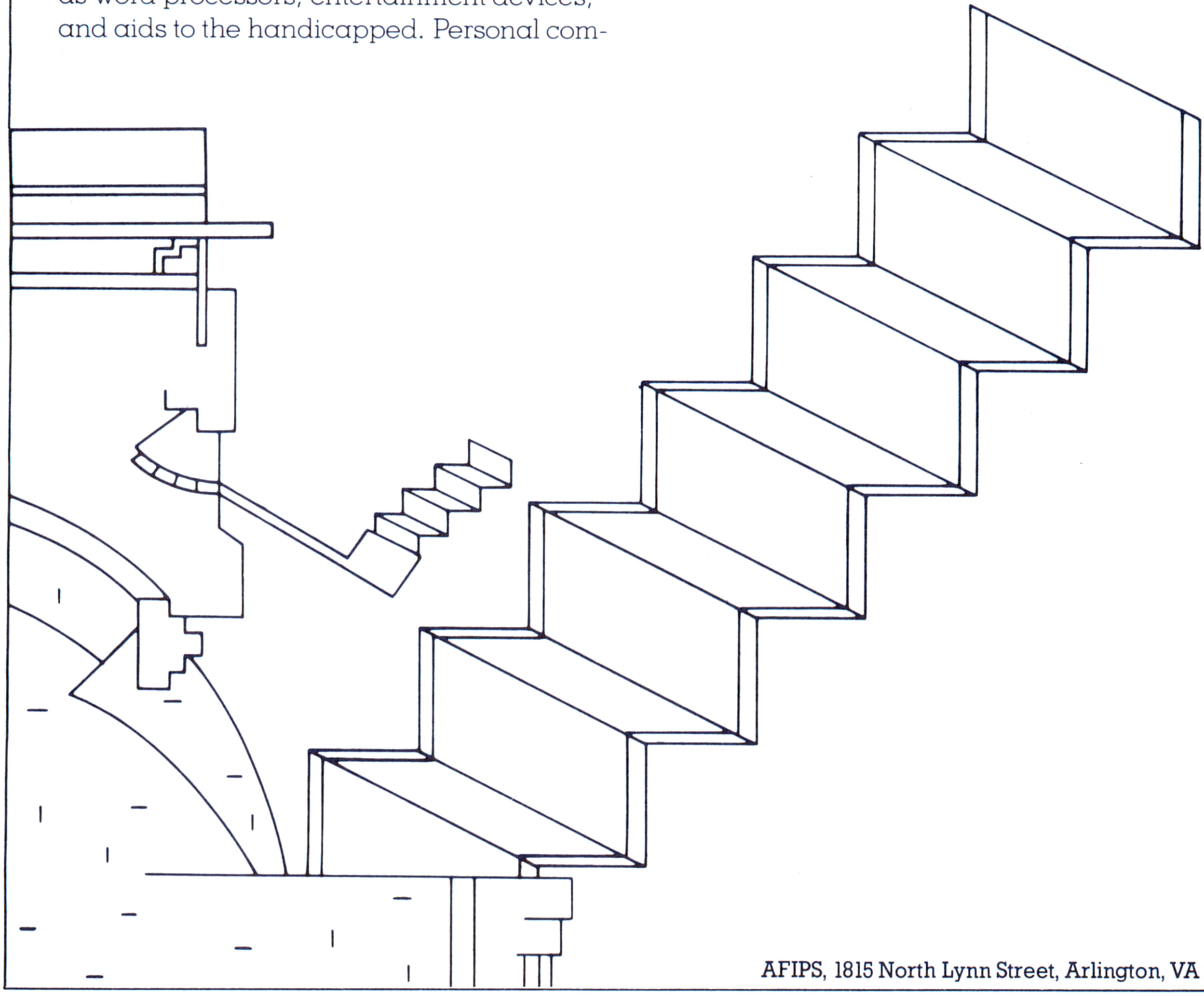
The 3-day festival features its own impressive roster of exhibitors plus over 50 learning sessions on every aspect of personal computers and their use.

Personal computers at home, at school, and in the executive suite. Personal computers as word processors, entertainment devices, and aids to the handicapped. Personal computer operating systems, programming languages, and software evaluation.

In addition, we've set aside a special area where demonstrations of personal computers will be conducted throughout the show. And we're awarding prizes for the most interesting use of personal computers.

If you're coming to NCC '80, be sure to make The Personal Computing Festival part of your visit.

Who knows—you may even win a prize.



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Personal Computing Festival Program Schedule

May 20 — Tuesday — 10:00 AM

High-Level Languages
Pascal Part I
Jim Gagne

Word Processing
Shopping by Objectives
Bill Radding

Portable Personal Computing
Jim Flournoy

1:00 PM

Higher-Level Languages
Pascal Part II
Jim Gagne

Computer Hardware Considerations & Applications
L Silvern

Forth Business Applications
Jim Flournoy

2:30 PM

Networks You Can Access With Your Personal Computer
Cliff Barney

May 21 — Wednesday — 10:00 AM

Using Computers to Overcome Disability Handicaps
Part I
Jeff Moyer
Mary Anne Glicksman

The Future of Personal Computing Panel
Verne Kallejian

Operating Systems
Roger Vass

1:00 PM

Using Computers to Overcome Disability Handicaps
Part II

Computer Networks-Technical
Craig Vaughn

Software Evaluation
Tom Williams

2:30 PM

Computer Music
Carl Helmers

May 22 — Thursday — 10:00 AM

Medical Computing for Microprocessors
Jim Gagne

Data Base Management
Doug Seeley

Computers In Education
Chris Morgan

1:00 PM

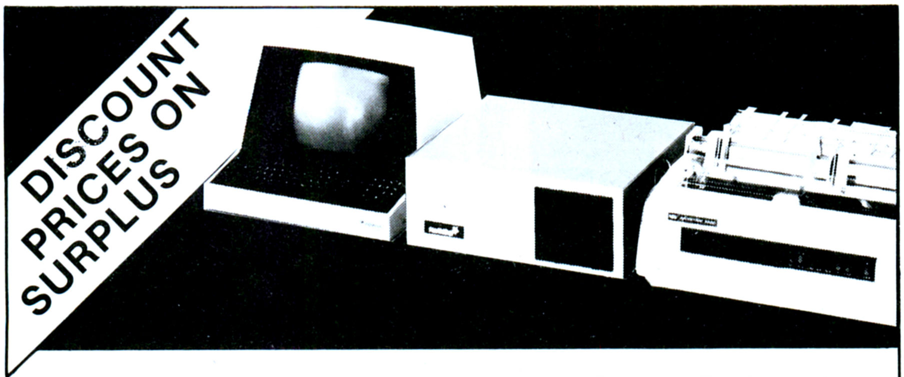
Use of Computers in Kindergarden thru Ninth Grade
Flora Russ

Business Applications
Nancy Leeper

Computers In Education Panel
Chris Morgan

2:30 PM

Programming Potpourri



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During each of the 4 days of the NCC, there will be discussions and papers related to the following major topics. A detailed schedule of events will be available at the conference.

Computer Architecture
Covers design of equipment and supporting technologies, and distribution through networking. Includes decisions relating to supersystems, survivability systems and data-base installation.

Applications of Computer Technologies
Explores the use of computers in entertainment, microcomputers and their impact, management of the computing tool and staff, and the role of inhouse and academic education and training.

Data Base Management & Communications
State-of-the-art, user-oriented sessions on the storage, retrieval, and transfer of data. From hardware considerations to natural-language access to a data base.

Office Automation
Every computer-related aspect of this explosive growth area, including electronic mail. How computers are used, managed, and integrated in an overall automated office.

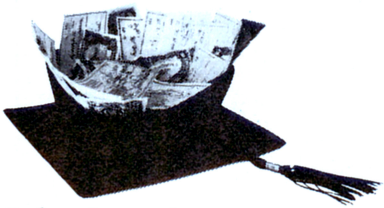
Simulation Technologies
Where we've been, where we are, and where we're going with computer modeling. Its value to small and large businesses and its role in decision support will be discussed. Special sessions on solar energy-simulation modeling will be included.

Software Engineering Technologies
Sessions on programming standards, software quality assurance, languages, and requirements engineering. Emphasis upon the needs and responsibilities of the user.

Social Dynamics and Special Topics
A broad spectrum of critical subjects: data security, legal issues, transborder data flow, societal impact, voice communications, venture capital and its effect upon technology.

Image Processing and Computers in Medicine
How image processing is used and will be used in industry and medicine. Trends in facsimile data coding, compression, and standards. How doctors use image-analysis display.

Professional Development Seminars
Full and half-day seminars for the professional who wants to come away with solutions and ideas he can implement now. Half-day seminars tie in with regular program sessions.



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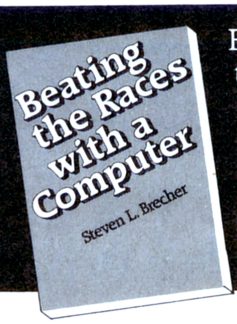

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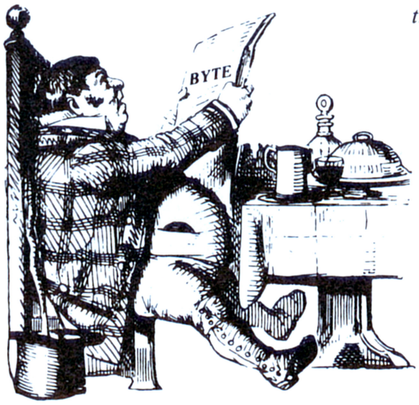

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What's New?

MISCELLANEOUS

RS-232C-Compatible Paper-Tape Reader

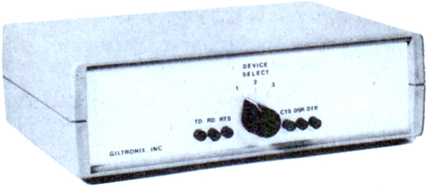
The Model 612 stand-alone paper-tape reader has the ability to read five- to eight-level tape and to transmit seven to eleven frames per character at 50 to 9600 bits per second (bps). It also features starting and stopping on character at all speeds, manual control or automatic on and off, 90 to 260 VAC, 50 to 60 Hz, and even, odd, or no parity. RS-232C, current loop, or parallel outputs are available. The price of the 612 is $656 to $854. Contact Addmaster Corp, 416 Junipero Serra Dr, San Gabriel CA 91776.

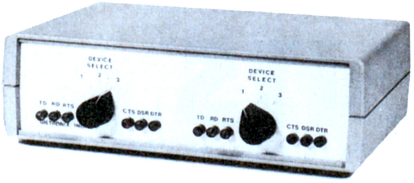
Circle 562 on inquiry card.

Bidirectional Interface for the PET

This interface package is a combination of hardware and software that enables any model of the Commodore PET to send and receive data on printers, terminals, and other peripherals. ASCII/ISO-7 characters are sent from the PET in serial or parallel mode but are received in serial mode only. Serial speeds are selectable at rates up to 240 characters per second (cps). The interface is available for either 20 mA current loop or transistor-transistor logic (TTL) serial or parallel. The machine-language program may be stored anywhere in programmable memory; the code used to terminate a message is selectable. The price for the package is £70 (approximately $160). Further details from Allen Computers, 16 Hainton Ave, Grimsby, South Humberside, ENGLAND.

Circle 563 on inquiry card.





Centronics-Compatible Switching and Monitoring Units

Giltonix Inc, 450 San Antonio Ave, Suite 44, Palo Alto CA 94306, has introduced a family of switching and monitoring units. The GRS 232 units are used for interfacing, configuring, and monitoring computer terminals, printers, and other peripherals that comply with the RS-232 and the IEEE-488 specifications. The new family consists of four models: the GRS 232-P24, -S24, -2P24, and -2S24. Each unit consists of a standard three-way switching system and an optional interface monitor. All the units can be cascaded and thereby allow interfacing of more than five devices. The systems can be ordered with signal monitoring capability. The units are priced at approximately $130.

Circle 564 on inquiry card.

Large Capacity Winchester Backup from Corvus

This backup system, the Mirror, employs a standard video cassette with a total capacity of 100 megabytes. In less than ten minutes, the 10 megabytes of data on the Corvus 8-inch hard disk can be transferred to a Mirror cassette. The video cassette should be of the VHS, Beta, or U-Matic format. If a larger data capacity is required, a reel-to-reel videotape recorder can be used. This approach to storage embodies standard television technology and proven cassette reliability. The Mirror uses the same Z80 and Corvus interface bus as the Corvus disk. The Mirror will interface to the Apple II, TRS-80, S-100, and LSI-11 computers. Data format in the Mirror is fully compatible with the standard NTSC signal. For error detection, the Mirror contains cyclic redundancy check (CRC) detection hardware. If unattended or remote operation is desired, a low-cost option is available to interface the Mirror to the Panasonic Omnivision NV-8200 cassette recorder allowing archival storage files to be created without operator interaction. The price of the Mirror is $790. Write Corvus Systems, 900 S Winchester Blvd, San Jose CA 95128.

Circle 565 on inquiry card.

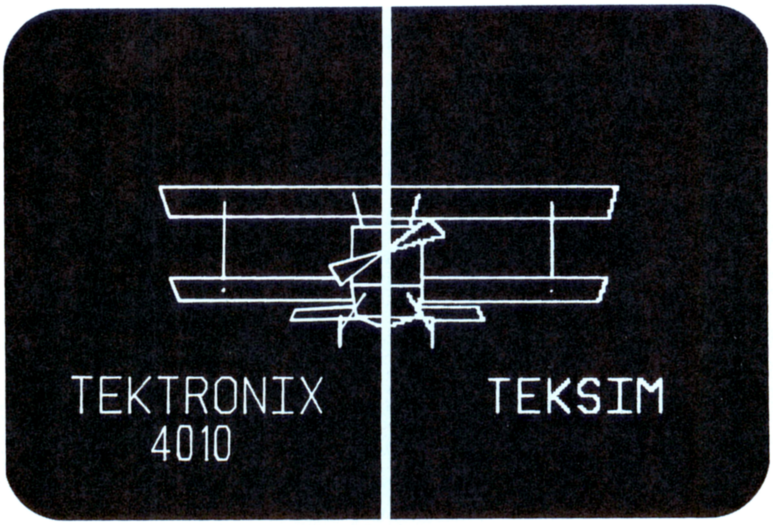
What's New?

MISCELLANEOUS

Speechlink Voice Recognition for S-100 Computers

Heuristics has announced its Model 20S-64 Speechlink 64-word voice input unit for S-100 bus computers. The 20S-64 is a speaker-programmed, isolated word-recognition device that recognizes up to 64 words at each instant. Vocabulary sets may be stored away and recalled when needed. This system will produce a usable vocabulary of several hundred words for data entry and system control applications. Word recognition is completed in 200 ms. Successive words must be separated by at least 100 ms of silence. Preprogramming of the Speechlink is necessary. The unit requires 2 K bytes of programmable memory for programs, and 64 bytes for each word in the vocabulary, up to a maximum of 4 K bytes. The price is $299 including board, microphone, and manual. Contact Heuristics Inc, 1285 Hammerwood Ave, Sunnyvale CA 94086.

Circle 441 on inquiry card.



Graphics Terminal Emulator for Apple IIs

TEKSIM, the Tektronix Simulator, employs distributed processing in its programming approach and uses the Apple's high-resolution plotting capabilities to emulate Tektronix 4010-series graphics terminals. No modification to the program in the remote computer is required to display or input graphic data. The TEKSIM-Apple combination features multicolored displays, selective erase, and a standard video output that lets any television set used with an RF converter function as a monitor. The suggested price for the plug-in device is $795, and it is available from ABW Corp, POB M 1047, Ann Arbor MI 48106.

Circle 442 on inquiry card.

Hardware and Software for Homebrewers

Snow Micro Systems Inc, POB 1704, Silver Spring MD 20902, provides low-cost hardware and software to personal computer users and clubs. Their bare boards are sold with schematics, layout drawings, and component lists. They are unassembled and come without parts. The company offers a troubleshooting service, if necessary. Some of their products include a front panel interface card, the Golem-80 S-100 Troubleshooter, a Station Controller Card, and more. Snow Micro software includes AMS-80 Version 5.8 debug packages, object code and source code, and other AMS-80 software related items. For prices and information, contact Snow Micro Systems at the above address.

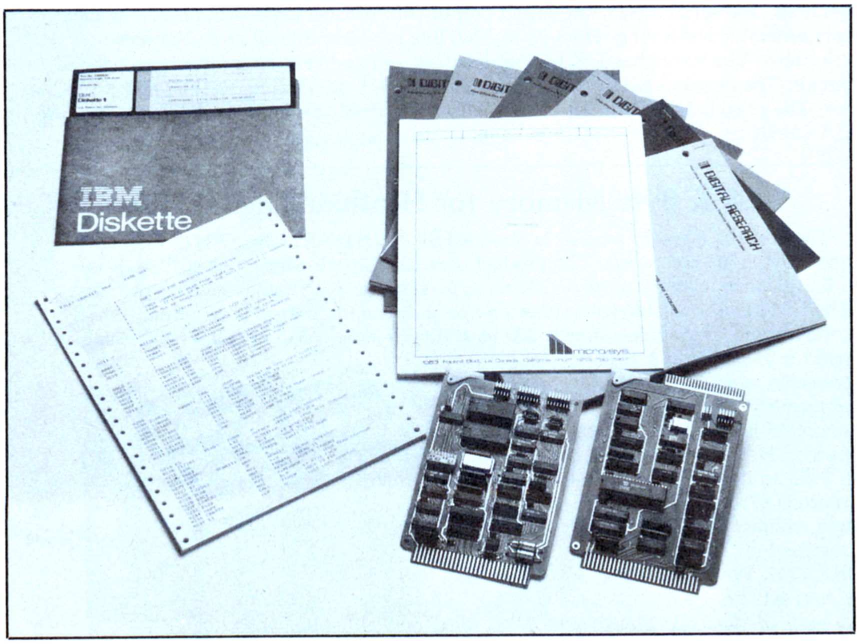
Circle 443 on inquiry card.

CP/M Package for the STD Bus

Micro/sys has developed a CP/M system for the STD Bus microcomputer card system. The Micro/sys package consists of two STD Bus-compatible cards, the SB8500 Floppy Disk Controller, the SB8420 Dual Serial Interface, and an eight-inch floppy disk containing the CP/M system. The SB8500 can control up to four floppy disk drives from a single STD Bus slot. The SB8420 provides communication with a console device, and a second serial port that can be used for printers and other devices. The cards are compatible with 8085 and Z80 microprocessors.

CP/M provides a disk file management, a text editor, and an 8080 assembler, a dynamic debugger, and various utilities. Price of the Micro/sys CP/M package is $695. For more information, contact Micro/sys Inc, 1353 Foothill Blvd, La Canada CA 91011.

Circle 444 on inquiry card.

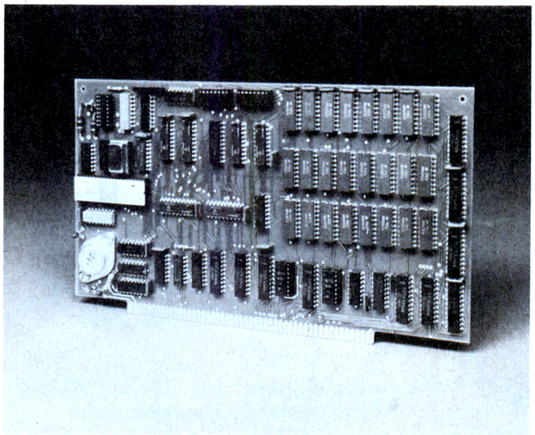


What's New?

MISCELLANEOUS

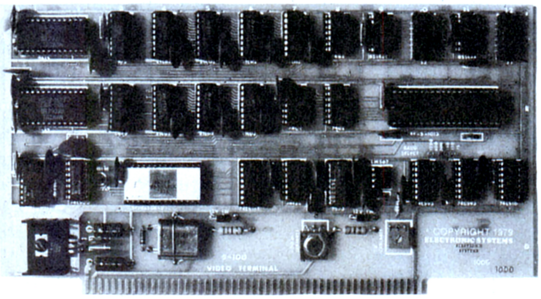
Video Graphics for S-100 Bus Systems

A single-card, high-density, computer-display system is being offered for the S-100 bus by International Product Development Incorporated (IPDI). The VG100 is designed for text-oriented applications. It has programmable fonts allowing any set of up to 256 characters to be defined in programmable memory with available software. The system can generate a combination of 16 gray levels or 16 colors, or combinations of both. The character field is 9 by 16 (or 144) pixels with a raster scan of 621 pixels. The entire character field can be changed at one time for fast animation. Adjoining character fields of any shape can be combined to create large continuous characters. The VG100 is configured in 12 K bytes of programmable memory and is selectable in three 4 K-byte blocks. The price is $645. For details, contact IPDI, 1708 Stierlin Rd, Mountain View CA 94043.



Circle 589 on inquiry card.

Video Terminal Board

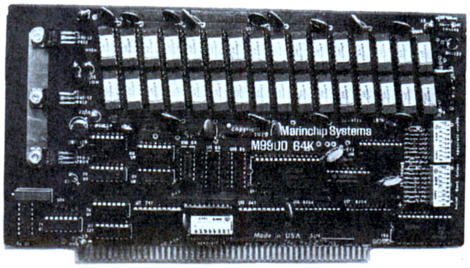


This board features full uppercase and lowercase, 5 by 7 dot matrix, 16 lines with 64 columns, and serial RS-232 input and output with parallel keyboard input. The data rate generator has a range from 75 to 1200 bits per second (bps) and is jumper-selectable. The board has 1 K byte of memory and an SFF96364 processor integrated circuit. The device is S-100 compatible. It requires ± 16 VDC at 100 mA and 8 VDC at 1A. The price is $199.95 in kit form. Contact Electronic Systems, POB 21638, San Jose CA 95151.

Circle 590 on inquiry card.

64 K Byte Memory for Heathkit/Digital H11

The CI-1103 memory module is designed for the Heathkit/Digital H11, LSI 11/2, and PDP 11/03 computers. The product uses 200 ns cycle time, type-4027, 4 K by 1-bit dynamic memory parts or 200 ns, type-4116, 16 K dynamic memory devices. The CI-1103 is available with either on-board distributed refresh or external refresh control logic. Data access time is 300 ns and cycle time is 525 ns. On-board memory-select is available in 2 K increments up to 128 K words of memory. Power consumption is under seven watts. The 8 K by 16 board is $390 and the 32 K by 16 board is $750. For information, contact Chrislin Industries Inc, 31352 Via Colinas #102, Westlake Village CA 91361.



Circle 591 on inquiry card.

Serial Interface Card for Apple II Computers

California Computer Systems' 7710A Asynchronous Serial Interface card enables the Apple II to communicate with all RS-232C serial devices. It is fully compatible with Apple Pascal. The card features selectable data rates from 50 to 19,200 bits per second (bps), 8- or 9-bit character transmission, and optional odd, even, or no parity. Software programmable interrupts, double buffered data input/output (I/O), and full handshaking are included. It is available in kit form or fully assembled and tested. The price for the card is $159.95. For more information, contact California Computer Systems, 250 Caribbean, Sunnyvale CA 94086.

Circle 592 on inquiry card.

Percom Board Interfaces Speak & Spell to Computer

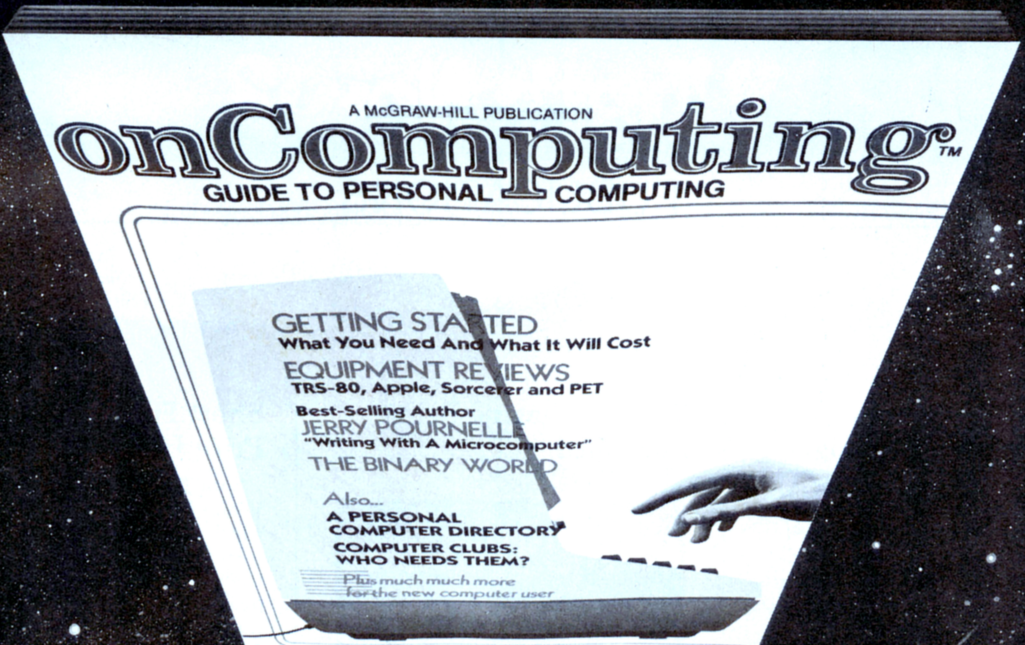
Percom Data Co, 211 N Kirby, Garland TX 75042, has announced production of a printed circuit board which will interface the Texas Instruments Speak & Spell learning aid to a computer. The "Speak 2 Me 2" allows communication with a Speak & Spell in BASIC, so a computer can talk using the words and phrases of a Speak & Spell unit. The board is installed in the battery compartment. Installation involves disassembly and some modification of the Speak & Spell unit. The board with instructions, TRS-80 driver software, and a TRS-80 cable sells for $69.95. The cable connects to the printer port and may be adapted for other computers.

Circle 593 on inquiry card.

Head-Cleaning Floppy Disks from Lifeboat

Lifeboat Associates, 2248 Broadway, New York NY 10024, has an important product for floppy-disk systems: head cleaning disks. The head-cleaning floppy disks are manufactured by attaching a lint-free nylon mat to a mylar substrate. The design avoids damaging abrasion, which keeps head wear to within industry standards for normal magnetic media. The disk is used by inserting it into the drive in the same manner as a floppy disk, and loading the head for 30 seconds. It is recommended that this procedure be used once per day as prevention against oxide build-up. The disks are available in 5¼- and 8-inch sizes for $20 each, or $45 for three. Each disk is suitable for three months of daily use.

Circle 594 on inquiry card.



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What's New?

PUBLICATIONS

Hardside Announces Expanded New Catalog

Hardside, a mail-order hardware company in Milford, New Hampshire, has announced the release of an expanded version of the Hardside catalog. Hardside features Radio Shack computer products at a discount price and also peripherals from other manufacturers which are suited to work with the TRS-80. The company specializes in computers and related hardware. The Hardside catalog is free from Hardside, 6 South St, Milford NH 03055.

Circle 572 on inquiry card.

Monthly Newsletter Covers the Office Computing Industry

Entitled the *Office Computing Industry Report* (OCIR), this monthly newsletter focuses on small-scale data processing, word processing, and data communications systems. OCIR also covers the merging of EDP and Business Machine distribution systems and support activities and the relationship of these new office computing systems to network-based information systems and distributed data processing. News analysis, market forecasts, new product reviews, vendor profiles, and technology forecasts are included. The *Office Computing Industry Report* is available from Vantage Research Inc, 2680 E Bayshore Rd, Mountain View CA 94043, for $195 per year in North America and $225 in Europe and Asia.

Circle 566 on inquiry card.

Supplies Catalog from Diablo

A 25-page brochure from Diablo Systems Inc, 24500 Industrial Blvd, Hayward CA 94545, illustrates and describes the variety of print wheels and ribbon cartridges designed for use on the company's Series 1640 and 1650, HyType, HyTerm, and matrix printers and terminals. The brochure contains a sample type line from all of the plastic and metallized daisy-wheel print elements. For copies of the brochure and the name of the nearest Diablo dealer, call (800) 227-2076, except in California where the number is (415) 443-2273.

Circle 567 on inquiry card.

S-100 Magazine Being Published

S-100
MICRO SYSTEMS
$2.00 USA
JAN/FEB 1980 VOL. 1/NO. 1

THE IEEE S-100 STANDARD HAS ARRIVED!

See Pages 18-43

Also in this Issue

An Introduction to CP/M* BY JAKE EPSTEIN .... Page 6
Modifying the SDS VDB-8024 BY JON BONDY .... Page 12
Computerized Bulletin Board Systems BY RUSSELL GORR Page 44
An 8080 Disassembler BY WILLIAM YARNALL .... Page 46

and more

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S-100 Microsystems is a new publication directed towards users of S-100 microcomputer systems. It is a forum on such S-100 topics as interfacing, CP/M, Pascal, Assembler, FORTRAN, and BASIC software. The magazine will also cover 16-bit microprocessors, multiprocessors, multitasking, timesharing, word processing, system development, data base management, scientific, and other applications and issues. It will be concerned with S-100 systems such as Cromemco, North Star, Intersystems, IMSAI, Poly Morphics, Processor Technology (Sol), Xitan, and others.

S-100 Microsystems is edited by Sol Libes. Sol has written 13 books, many magazine articles, and has edited several newsletters. He is the founder and past president of the Amateur Computer Group of New Jersey, the largest personal computer organization in the world. The first issue of *S-100 Microsystems* includes the complete proposed Institute of Electrical and Electronics Engineers (IEEE) S-100 Standard, the first part of a tutorial on CP/M, an article on modifying the SDS Video Board for Pascal editor functions, the source code for an 8080 disassembler, a directory of Computerized Bulletin Board Systems (CBBS), and more. *S-100 Microsystems* will be published six times a year. A sample copy is $2. For subscriptions and additional information, contact *S-100 Microsystems*, POB 1192, Mountainside NJ 07092.

Circle 568 on inquiry card.

Short Form Catalog and Price List

Sara-Tech Electronics Inc, POB 692, Venice FL 33595, has published a catalog which includes systems and peripherals from Cromemco, North Star, Centronics, Heath, and many more companies. They also have a listing for computer-paper forms for all systems. Sara-Tech sells systems, peripherals, and software of most major companies.

Circle 569 on inquiry card.

A Book on Computerized Typesetting

Donald Knuth, author of *The Art of Computer Programming*, has written *TEX and METAFONT, New Directions in Typesetting*, which describes new techniques in typesetting. Dr Knuth explains how TEX, originally designed for use in setting technical and mathematical text, can be applied to all computerized typesetting. METAFONT is a system for the design of alphabets. It is suited for implementation on raster-based devices that print or display text. With it, computers can draw new fonts of characters in seconds. TEX and METAFONT represent improvements in typesetting that will benefit the scientific and technical community. The book consists of three parts. The first is a lecture on mathematical typography; the two other parts describe TEX and METAFONT. The book costs $12 and is available from Dept TM:X, Digital Press, Educational Services, Digital Equipment Corp, 12-A Esquire Rd, N Billerica MA 01862.

Circle 570 on inquiry card.

Software Catalog for Heath Users

The Heath Users' Group has published a catalog of programs written by Heath users for all Heath computers. The programs described include games, financial applications, utilities, computer-assisted education, and amateur radio. The catalog lists the language and designated computer next to the program. Prices are given, along with services of the Users' Group. For more information, contact Heath Users' Group, Hilltop Rd, St Joseph MI 49085.

Circle 571 on inquiry card.

SYSTEMS

Intellivision from Mattel

Mattel Electronics is introducing six cartridges for its home computer system, Intellivision Intelligent Television. Soccer, Golf, Skiing, Boxing, Tennis, and Sea Battle join the existing fourteen cartridges, which range from sports and games to children's learning. Intellivision's Master Component contains a 16-bit microprocessor that delivers simulated sound effects, three-part harmony, and color reproduction. Two 12-button, hand-held controllers, each with four play-action keys, and a 16-directional control knob for movement of screen objects are included. The unit attaches to any television set.

The Keyboard Component uses programmed cassettes and features a keyboard and a digital cassette system with fast-forward and tape search. Its programs include Physical Fitness, Speed Reading, Stock Analysis, and Guitar Lessons. The Master Component will retail for approximately $300 or less. The Keyboard Component will cost around $550 and the cartridges will cost approximately $30, with the cassettes priced slightly under $30. For information, contact Mattel Electronics, 5150 Rosecrans Ave, Hawthorne CA 90250.

Circle 586 on inquiry card.

Computer System from NNC

NNC Electronics, 15631 Computer Ln, Huntington Beach CA 92649, has released the System 80 computer. The System 80 uses a 4 MHz Z80 microprocessor and features a floppy-disk controller and two dual-density, 8-inch disk drives, 32 K bytes of programmable memory, two serial ports, and the CP/M operating system. The eight-slot S-100 card cage has five slots available for expansion. The desktop unit weighs less than 29 kg (65 pounds) and retails for $3995.

Circle 587 on inquiry card.

Altos Announces a Hard-Disk System

The Altos Systems ACS8000-6 can take advantage of as much as 58 megabytes of hard disk storage. The system can control up to four 14.5-megabyte Shugart disks using Winchester-type technology. Altos designed the ACS8000-6 series so that it handles up to four floppy-disk drives. The floppy units could accommodate another 4.0 megabytes of on-line storage. The ACS8000-6 family comes with input/output (I/O) control to support two serial and two parallel ports in addition to the four serial ports to which the users are connected. The hard-disk controller features direct memory access (DMA) operation; firmware address checking; a high-speed first-in, first-out (FIFO) buffer; and intelligent sequencing. The controller firmware contains a routine that automatically double-checks all addresses before performing any disk writes. The FIFO enables the system to transfer data at a 7 million bits per second (bps). The system will support asynchronous, bisynchronous, and networking communications protocols and configurations. Prices range from $9450 for a single-user system with two floppy-disk drives and one 14.5-megabyte hard disk, to $14,260 for the four-user, 29-megabyte system with two dual-sided floppy-disk units. For details, contact Altos, 2338A Walsh Ave, Santa Clara CA 95050.

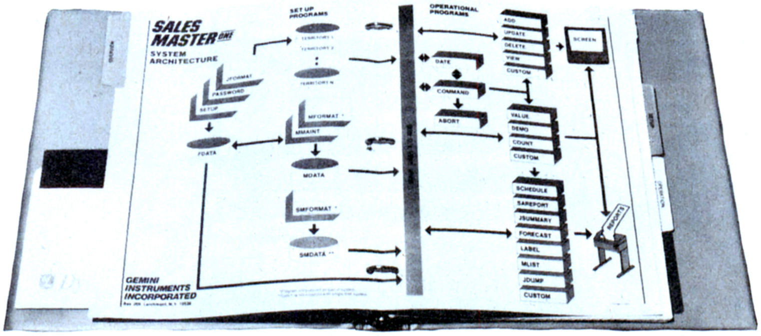
Circle 588 on inquiry card.

What's New?

SOFTWARE

A North Star Program for Salesmen

The Sales Master One is a collection of 22 programs designed by salespeople for salespeople. The Sales Master One is territory-oriented, allowing users to pinpoint selling activities to a particular location. The system generates reports on sales activities, forecasts, and schedules. Various other reports assist in daily selling efforts. The system has room for 400 jobs on one 5¼-inch floppy disk. The package contains a program that allows modifications to be made without the need to refer to the operations manual. A customized disk-operating system allows the package to be run on Cromemco, Dynabyte, and Processor Technology computers. Sales Master One comes on a 5¼-inch floppy disk with a manual for $375. Contact Gemini Instruments Inc, POB 205, Larchmont NY 10538.



Circle 573 on inquiry card.

Software from Compucolor

Compucolor Corp, POB 569, Norcross GA 30091, has released several software programs for the Compucolor II system.

The BASIC Editing package features six programs including FRED (Friendly Editor), RENUM (Renumber), MERGE, COMPAC, REMPAC (Deletes Remarks), and BASSRC (BASIC-to-Source Conversion). FRED, the most useful of the programs, allows the user to edit any line, move existing lines, delete a range of lines, and to search for the occurrence of any string, variable, or command within a program. The package comes on a floppy disk and costs $29.95.

Statistics is a series of three disks that is useful for engineering applications. The floppy disks are entitled *Statistics I*, *II*, and *III*. Each disk contains five programs including plot, stat, polreg (polynomial regression), index, and more. Common to all three packages is a file manager program that generates, maintains, and displays files for use by other programs. *Statistics I* sells for $24.95. *Statistics II* and *III* sell for $29.95 each.

Compucolor has also released Soundware. This program includes the software and hardware necessary to create sounds on the Compucolor II. It is written in BASIC, with a range of two to three octaves. The price is $49.95.

Circle 574 on inquiry card.

TLC-LISP for Z80 Systems

The LISP Company has announced its version of the LISP language for the Z80. TLC-LISP allows manipulation of functions as data objects; promotes object-oriented programming style; defines functions with a variable number of parameters; includes structured iteration and nonstructured escape mechanisms; contains complete string and character processing capabilities; and includes fixed- and floating-point arithmetic. The language system also contains a table-driven scanner; comprehensive error control, an autoload feature that "virtualizes" infrequently used functions and constants to disk files, freeing programmable memory; and execution speeds comparable to a KA-10 running MACLISP. Over 150 utility functions are provided. TLC-LISP is available for Z80 CP/M systems and other versions will be available soon. A detailed manual is $15, and the system on 5- or 8-inch floppy disks is $150. Write The LISP Co, POB 487, Redwood Estates CA 95044.

Circle 575 on inquiry card.

Software Catalog for TRS-80 Level II

National Software Marketing Inc, POB 6195, Hollywood FL 33021, has announced a free catalog of software for the TRS-80 Model II. The software described includes accounts receivable and payable, general ledger, payroll, inventory, rental mangagement, and a variety of financial and mathematical programs. These systems will operate on the 64 K-byte model with the built-in disk. The programs have list prices of $15 to $100.

Circle 576 on inquiry card.

A Gomoku Program

Five Stones Software, POB 1369, Station B, Ottawa, Ontario, K1P 5R4, CANADA, has released a Gomoku program for North Star Horizon disk-operating systems and CP/M-based systems. The program features a book of openings with 200 entries, the ability to take back moves, a 19 by 19 board, recent moves displayed along with the board, and the ability to customize to different screen sizes. The program requires a minimum of 32 K bytes of programmable memory and is available on 5-inch floppy disks for $29.95.

Circle 577 on inquiry card.

PLMX — A Language That Communicates with All 8- or 16-bit Microprocessors

PLMX is a universal high-level language for microprocessors. It can be used with all 8- or 16-bit microprocessors and was designed primarily for use in microcomputer product development systems and in real-time process-control applications. PLMX syntax is identical to PL/M, so the entire library of existing PL/M programs can be compiled under PLMX. PL/M programs may be used on microprocessors other than the 8080 through the PLMX compiler. PLMX is a true compiler, allowing fast compiling times —useful for real-time applications. It has been developed as a user-oriented language. There are no arbitrary formatting rules or line numbers. Comments may occur anywhere in the source text, except within reserved words, identifier names, and numbers. PLMX is priced at $1000, which includes an 8-inch compiler floppy disk and instruction manuals. To obtain additional information, write Systems Consultants Inc, Product Development Group, 4015 Hancock St, San Diego CA 92110.

Circle 578 on inquiry card.

What's New?

SOFTWARE

High-Speed Sort Utility for Ohio Scientific

BPSort is a high-speed, assembly language, sort/merge utility program for Ohio Scientific floppy and hard disk systems. It is capable of sorting 20 K bytes in ten seconds. Files can be an entire hard or floppy disk in length. BPSort handles fixed length records. Five keys can be specified for ascending and/or descending sequence. Sort parameters are established using a BASIC program. BPSort is OS-DMS compatible and is supplied as part of the BPS, an interactive data management system. It is sold in single-user licensed copies for $124. Earlier versions can be updated for $25. Order from BPS, 322 W 57th St, New York NY 10019.

Circle 579 on inquiry card.

Microsoft Announces TRS-80 Model II Software

Microsoft is selling TRSDOS-compatible versions of its COBOL and BASIC compilers for the TRS-80 Model II. Both compilers provide complete facilities for commercial or in-house software development, including Microsoft's macroassembler and linking loader. The COBOL-80 compiler is an ANSI-74 implementation of COBOL. The BASIC compiler produces object code that runs faster than interpreted BASIC programs. All Microsoft BASIC language features are supported. The BASIC compiler is also available in a version for the TRS-80 Model I. Microsoft is the author of Radio Shack's BASICs. The BASIC compiler is $395,and the COBOL-80 compiler is $750. Contact Microsoft, 10800 NE Eighth, Suite 819, Bellevue WA 98004.

Circle 580 on inquiry card.

Microsoft to Market muLISP and muMATH

Microsoft has become the distributor for muLISP-79 and muMATH-79, which were written by the Soft Warehouse of Honolulu, Hawaii. muLISP offers all of LISP's programming features, including 83 LISP functions, flexible program-control structures, and infinite precision integer arithmetic in any desired radix (2 to 36). The modular muMATH symbolic mathematics package is useful for scientific and engineering applications. The muMATH routines are written in muSIMP, which is included in the package. Both programs run with CP/M systems. The muLISP program costs $200 and the muMATH/muSIMP-79 program is priced at $250. Contact Microsoft, 10800 NE Eighth, Suite 819, Bellevue WA 98004.

Circle 581 on inquiry card.

Six Programs for TRS-80 Level II and Disk-Operating System

International Data Services has developed Microsketch III, a graphics program for the Level II with 16 K bytes of programmable memory for $7.95. Freakout is a keyboard-generated graphics and sound program for the Level II with 4 K bytes of programmable memory for $3.95. The number-base conversion program converts any base to any other base between 2 and 16. It is priced at $3.95. Three other programs are available for disk BASIC with 16 K bytes of programmable memory. BASIC to Electric Pencil file conversion, machine language to BASIC data statement conversion, and mail-list file uppercase to uppercase-and-lowercase conversion programs all cost $3.95. Contact IDS, 340 W 55th St, New York NY 10019.

Circle 582 on inquiry card.

RCA's BASIC I Compiler/Interpreter for COSMAC Development System

RCA's BASIC I Compiler/Interpreter CDP18S834 is a software package that can accelerate program development on the COSMAC DOS Development System CDP18S007. The package gives the user the option of developing and running programs in BASIC I or converting the programs to object code. The output of the compiler is assembled by the COSMAC macroassembler to produce the executable object code. Some of the features of the compiler/interpreter include: 70 characters per line, variable designation by a single capital letter, and fixed-point arithmetic. BASIC I functions include MOD, AND, OR, XOR, and USR. The USR function extends BASIC I by means of machine-language subroutines. Some of the statements available to the programmer are REM, LET, GOTO, IF, INPUT, WFLN, and NEW. With a manual, the package is priced at $300. Contact RCA Solid State Div, POB 3200, Somerville NJ 08876.

Circle 583 on inquiry card.

A Data Base System for the TRS-80

V R Data Corp, 777 Henderson Blvd, Folcroft PA 19032, has announced a Data Base system for the TRS-80 Models I and II. The Data Base system provides the capability to define and create customized records for various applications. Records may contain up to 25 user-defined variable-length fields and up to 250 characters per record. A dictionary of the fields and their characteristics is maintained by the system. Records may be added, deleted, and extended; field contents may be changed, and fields may be removed or added to the record or renamed at any time. Records may also be linked logically. The records may be sorted by any combination of fields in ascending or descending order. Reports are fully user-definable and may be routed to a printer or the video display. This four-program BASIC system requires 48 K bytes of programmable memory, a minimum of two disk drives and a line printer for the TRS-80 Model I, with 300 records per disk. Programs are available for the Model II with 950 records per disk.

Circle 584 on inquiry card.

Machine-Language Program for TRS-80 Disk Systems

The ST80-111 machine-language program is written for the TRS-80 Level II system. This package includes programs that allow users to talk to a time-sharing computer, transfer files to and from the central computer, and customize the ST80-111 system. Some of the programs included in the system are a BASIC program that creates translation tables, one that tells if a file is American Standard Code for Information Interchange (ASCII) or binary, a binary-to-ASCII conversion program, and one that changes machine-language programs to binary. The ST80-111 has been run on HP2000, IBM 370 and 360, PDP-11, Burroughs, Apple, and North Star systems. The minimum requirements for the system are the TRS-80 Level II with one disk drive and 16 K bytes of memory, an RS-232C board, and a modem. The package is produced by Small Business Systems Group, Main St and Lowell Rd, Dunstable MA 01827, and is priced at $150.

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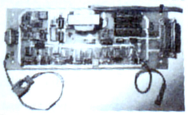
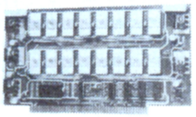


Orignate, RS-232 and 20 mA compatable, Full duplex, and half duplex, direct connect or acoustic coupled, on board power supply, carrier detect light, DB25 plug, 300 BAUD, Type 103 compatable frequencies, Bare board Part No. 2000, $19.95, Kit Part No. 2000A, $99.95.

16K EPROM

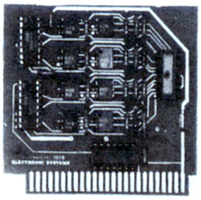


Uses 2708 EPROMS, memory speed selection provided, addressable anywhere in 65K of memory, can be shadowed in 4K increments. Board only $24.95 part no. 7902, with parts less EPROMs $49.95 part no. 7902A.

PET COMPUTER

With 16K & monitor - $795. Dual Disk Drive - $1095

OPTO-ISOLATED PARALLEL INPUT BOARD FOR APPLE II

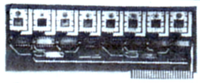


There are 8 inputs that can be driven from TTL logic or any 5 volt source. The circuit board can be plugged into any of the 8 sockets of your Apple II. It has a 16 pin socket for standard dip ribbon cable connection. Board only $15.00. Part No. 120, with parts $69.95. Part No. 120A.

VIDEO TERMINAL

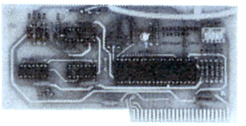
16 lines, 64 columns • Upper and lower case • 5x7 dot matrix • Serial RS-232 in and out with TTL parallel keyboard input • On board baud rate generator 75, 110, 150, 300, 600, & 1200 jumper selectable • Memory 1024 characters (7-21L02) • Video processor chip SFF96364 by Neculonic • Control characters (CR, LF, →, ←, ↑, ↓, non destructive cursor, CS, home, CL • White characters on black background or vice-versa • With the addition of a keyboard, video monitor or TV set with TV interface (part no. 107A) and power supply this is a complete stand alone terminal • also S-100 compatible • requires +16, & −16 VDC at 100mA, and 8VDC at 1A. Part No. 1000A $199.95 kit.

PARALLEL TRIAC OUTPUT BOARD FOR APPLE II



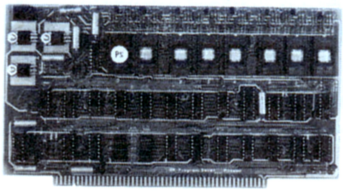
This board has 8 triacs capable of switching 110 volt 6 amp loads (660 watts per channel) or a total of 5280 watts. Board only $15.00 Part No. 210, with parts $119.95 Part No. 210A.

APPLE II SERIAL I/O INTERFACE



Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. • Also watches DTR • Board only $15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled $62.00 Part No. 2C

8K EPROM PICEON



- Programs 2708's address relocation of each 4K of memory to any 4K boundary
- Power on jump and reset jump option for "turnkey" systems and computers without a front panel
- Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.

WAMECO PRODUCTS

With ELECTRONIC SYSTEMS parts

FDC-1 FLOPPY CONTROLLER BOARD will drive shugart, pertek, remex 5" & 8" drives up to 8 drives, on board PROM with power boot up, will operate with CPM (not included). PCBD $42.95

FPB-1 Front Panel. (Finally) IMSAI size hex displays. Byte or instruction single step. PCBD $42.95

MEM-1A 8Kx8 fully buffered, S-100, uses 2102 type RAMS. PCBD .... $24.95, $168 Kit

QMB-12 MOTHER BOARD, 13 slot, terminated, S-100 board only .... $34.95 $89.95 Kit

CPU-1 8080A Processor board S-100 with 8 level vector interrupt PCBD .. $25.95 $89.95 Kit

RTC-1 Realtime clock board. Two independent interrupts. Software programmable. PCBD .... $25.95, $60.95 Kit

EPM-1 1702A 4K EPROM card PCBD .... $25.95 $49.95 with parts less EPROMS

EPM-2 2708/2716 16K/32K EPROM card PCBD .... $24.95 $49.95 with parts less EPROMS

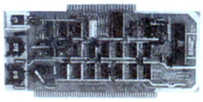
QMB-9 MOTHER BOARD. Short Version of QMB-12. 9 Slots PCBD .... $30.95 $67.95 Kit

MEM-2 16Kx8 Fully Buffered 2114 Board PCBD .... $25.95, $269.95 Kit

D.C. HAYES MICROMODEM

Fully S-100 bus compatible including 16-bit machines and 4 MHz processors. • Two software selectable Baud rates—300 Baud and a jumper selectable speed from 45 to 300 Baud. (110 standard). Supports originate and answer modes. • Direct-connect Microcoupler. This FCC-registered device provides direct access into your local telephone system, with none of the losses or distortions associated with acoustic couplers and without a telephone company supplied data access arrangement. • Auto-Answer/Auto-Call. The MICROMODEM 100 can automatically answer the phone and receive input; it can also dial a number automatically. • Automatic Reset and Disconnect. • Software compatible with the D.C. Hayes Associates 80-103A Data Communications Adapter. Micromodem-DCHA32625—$379.95

TIDMA

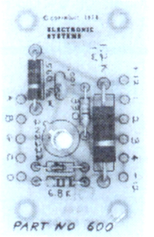


Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate • S-100 bus compatible • Board only $35.00 Part No. 112, with parts $110.00 Part No. 112A.

SYSTEM MONITOR

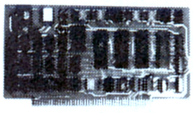
8080, 8085, or Z-80 System monitor for use with the TIDMA board. There is no need for the front panel. Complete with documentation $12.95.

RS-232/TTY INTERFACE



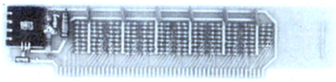
This board has two active circuits, one converts RS-232 to 20 mA, the other converts 20 mA to RS-232. Requires +12 and -12 volts. $9.95 Part No. 600A Kit.

SERIAL I/O



Four Serial I/O RS-232 ports. S-100 Bus, Software or jumper selectable baud rate (110, 300, 600, 1200, 2400, 4800, 9600, 19.2K), on board Xtal baud rate generator, Addressing, switch selectable, Parity or no parity (odd or even) switch selectable, 1 or 2 stop bits, 5 to 8 bits/character. Board only $29.95, Part No. 7908. With parts (kit) $199.95, Part No. 7908A.

S-100 BUS ACTIVE TERMINATOR



Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A

To Order: Mention part no. description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders in the U.S. only, or a VISA or Master Charge no., expiration date, signature, phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 10% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. 24 hour order line (408) 448-0800

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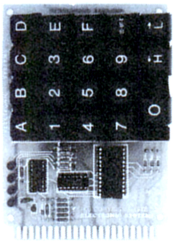
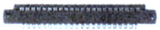
Circle 245 on inquiry card.

HEX ENCODED KEYBOARD



Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX- 3A. 44 pin edge connector $4.00 Part No. 44P.



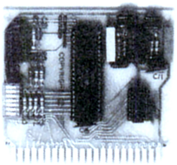
T.V. TYPEWRITER

● Stand alone TVT ● 32 char/line, 16 lines, modifications for 64 char/line included ● Parallel ASCII (TTL) input ● Video output ● 1K on board memory ● Output for computer controlled curser ● Auto scroll ● Non-destructive curser ● Curser inputs: up, down, left, right, home, EOL, EOS ● Scroll up, down ● Requires +5 volts at 1.5 amps, and -12 volts at 30 mA ● All 7400, TTL chips ● Char. gen. 2513 ● Upper case only ● Board only $39.00 Part No. 106, with parts $145.00 Part No. 106A

44 BUS MOTHER BOARD

Has provisions for ten 44 pin (.156) connectors, spaced 3/4 of an inch apart. Pin 20 is connected to X, and 22 is connected to Z for power and ground. All the other pins are connected in parallel. This board also has provisions for bypass capacitors. Board cost $15.00 Part No. 102. Connectors $3.00 each Part No. 44WP.

UART & BAUD RATE GENERATOR



● Converts serial to parallel and parallel to serial ● Low cost on board baud rate generator ● Baud rates: 110, 150, 300, 600, 1200, and 2400 ● Low power drain +5 volts and -12 volts required ● TTL compatible ● All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. ● All connections go to a 44 pin gold plated edge connector ● Board only $12.00 Part No. 101, with parts $35.00 Part No. 101A, 44 pin edge connector $4.00 Part No. 44P

RS-232/20mA INTERFACE

This board has two passive, opto-isolated circuits. One converts RS-232 to 20mA, the other converts 20mA to RS-232. All connections go to a 10 pin edge connector. Requires +12 and -12 volts. Board only $9.95, part no. 7901, with parts $14.95 Part No. 7901A.

ASCII TO CORRESPONDENCE CODE CONVERTER

This bidirectional board is a direct replacement for the board inside the Trendata 1000 terminal. The on board connector provides RS-232 serial in and out. Sold only as an assembled and tested unit for $249.95. Part No. TA 1000C

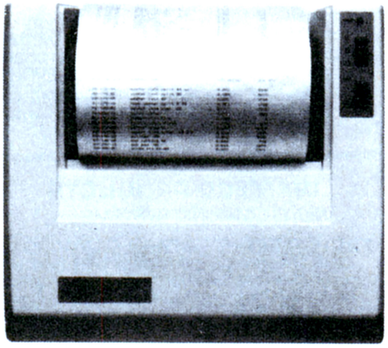
ASCII KEYBOARD

53 Keys popular ASR-33 format • Rugged G-10 P.C. Board • Tri-mode MOS encoding • Two-Key Rollover • MOS/DTL/TTL Compatible • Upper Case lockout • Data and Strobe inversion option • Three User Definable Keys • Low contact bounce • Selectable Parity • Custom Keycaps • George Risk Model 753. Requires +5, -12 volts. $59.95 Kit.

ASCII KEYBOARD

TTL & DTL compatible • Full 67 key array • Full 128 character ASCII output • Positive logic with outputs resting low • Data Strobe • Five user-definable spare keys • Standard 22 pin dual card edge connector • Requires +5VDC, 325 mA. Assembled & Tested. Cherry Pro Part No. P70-05AB. $119.95.

COMPRINT PRINTER



Printing Characteristics: 225 characters/second (170 lines/minute) throughput ● 9 horizontal x 12 vertical matrix ● 96 ASCII character set with upper and true lower case ● 80 characters/line ● 5.8 lines/inch
Buffer Memory: standard 256 bytes; ● optional; 2,048 bytes (buffer memory option designated as Model 912-2K), add $149.95.
Paper Requirements: electrosensitive type (aluminum coated) ● 8-1/2 inch width ● 3.7 inch max. (300 ft.) roll diameter.
Model 912-S Interfacing: serial interface RS232 and 20 mA current loop ● BAUD rates 110, 150, 300, 600, 1200, 2400 and 4800 are strap selectable.
Model 912-P Interfacing: parallel interface, IEEE-488 and 8 bit parallel (strobe/ acknowledge). Model 912-S, Part No. CPIA, 32118, $579.95. Model 912-P, Part No. CPIA, 32117, $559.95.

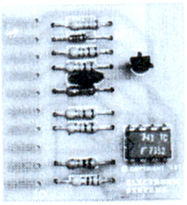
T.V. INTERFACE

● Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple ● Power required is 12 volts AC C.T., or +5 volts DC ● Board only $7.60 part No. 107, with parts $13.50 Part No. 107A

SOROC IQ 120

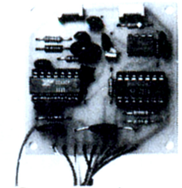
Upper/lower case display • Numeric keypad & cursor keys • Protected fields, ½ intensity display • RS 232 interface & aux. port. IQ120—$799.95 • IQ140 Detachable keyboard—$1199.95

RS-32/TTL INTERFACE



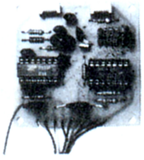
● Converts TTL to RS-232, and converts RS-232 to TTL ● Two separate circuits ● Requires -12 and +12 volts ● All connections go to a 10 pin edge connector, kit $9.95 Part No. 232A 10 Pin edge connector $3.00 part No. 10P.

TAPE INTERFACE



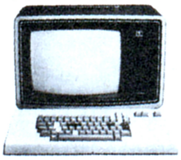
● Converts a low cost tape recorder to a digital recorder ● Works up to 1200 baud ● Digital in and out are TTL-serial ● Output of board connects to mic. in of recorder ● Earphone of recorder connects to input on board ● No coils ● Requires +5 volts, low power drain ● Board only $7.60 Part No. 111, with parts $29.95 Part No. 111A

MODEM



● Type 103 ● Full or half duplex ● Works up to 300 baud ● Originate or Answer ● Serial TTL input and output ● connect 8 Ω speaker and crystal mic. directly to board ● Requires +5 volts ● Board only $7.60 Part No. 109, with parts $29.95 Part No. 109A.

COMPUCOLOR II



With reg. keyboard MOD3 8K $1595.95 MOD4 16K $1695.95 MOD5 32K $1995.95 Now includes $250 more, worth of software and accessories with 101 key option add $134.95 with 117 key option add $179.95

DC POWER SUPPLY

● Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. ● Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. ● Board only $12.50 Part No. 6085, with parts excluding transformers $42.50 Part No. 6085A

To Order: Mention part no. description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders in the U.S. only, or a VISA or Master Charge no., expiration date, signature, phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 10% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. 24 hour order line (408) 448-0800

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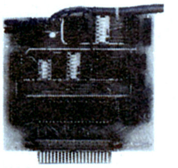
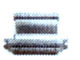
Circle 246 on inquiry card.

TRS-80 SERIAL I/O

● Can input into basic ● Can use LLIST and LPRINT to output, or output continuously ● RS-232 compatible ● Can be used with or without the expansion bus ● On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. D.T.R. line ● Requires +5, -12 VDC ● Board only $19.95 Part No. 8010, with parts $59.95 Part No. 8010A, assembled $79.95 Part No. 8010 C. No connectors provided, see below.



EIA/RS-232 connector Part No. DB25P $6.00, with 9'. 8 conductor cable $10.95 Part No. DB25P9.

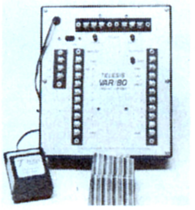


3' ribbon cable with attached connectors to fit TRS-80 and our serial board $19.95 Part No. 3CAB40.

COMPUCRUISE

$129.95; with cruise control $169.95

THE TELESIS VAR-80 INTERFACE UNIT



For the TRS-80 with Level II Basic ● Provides 8 outputs ● Provides 8 inputs ● 2 ft. of interconnecting cable w/connector ● Plugs directly into TRS-80 ● Power supply provided ● Assembled and tested. Part No. VAR80, Introductory price $109.95.

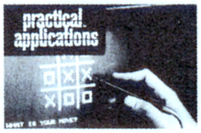
GAME PADDLES & SOUND

Includes: 2 game paddles, interface, software, speaker, power supply, full documentation including: schematics, theory of operation, and user guide; plus 2 games on cassette (Pong and Starship War). $79.95 Complete Part No. 7922C

DIGICOM DATA PRODUCTS INC.
Series 312 Acoustic Coupler

300 BAUD Originate, Part No. AC3122, $219.95. 300 BAUD Answer, Part No. AC3122, $219.95. 300 BAUD Answer/Originate, Part No. AC3123, $229.95.

LIGHT-PEN For Your TRS-80



Your TRS-80 Light-Pen is a carefully engineered instrument and with the proper care will give satisfactory use and many years of service. Part No. TRS80LP $24.95.

SYSTEM EXPANSION from LNW Research

● Serial RS232C/20 mA I/O ● Floppy controller ● 32K bytes memory ● Parallel printer port ● Dual cassette port ● Real-time clock ● Screen printer bus ● Onboard power supply ● Software compatible ● Solder mask, silk screen. PC board and user manual, Part No. LNW80, $69.95.

DISKETTES

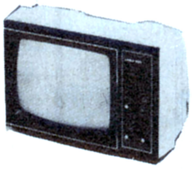
Verbatim
minidisk
Verbatim

Box of 10, 5" $29.95, 8" $39.95.
Plastic box, holds 10 diskettes, 5" - $4.50, 8" - $6.50.

16K RAMS

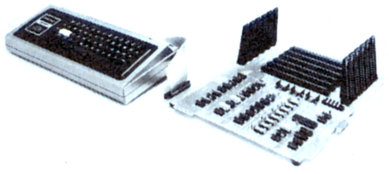
For the Apple, TRS-80 or Pet $8 each Part No. 4116/2117.

LEEDEX MONITOR



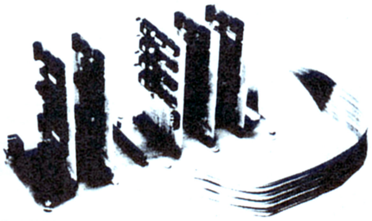
12" Black and White • 12 MHz Bandwidth • Handsome Plastic Case • $139.00

S-100 INTERFACE



AN S-100 bus Adapter—Motherboard for the TRS-80. Kit, Part No. HUH81DLXK, $295.95. Assembeled, Part No. HUH81DLXA, $375.95.

NOW! A FULL SUPPORT SYSTEM FOR TRS-80

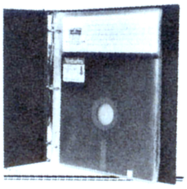


● 32K of RAM ● EPROM firmware ● Disk control ● Data acquisition ● Parallel I/O ● Serial I/O ● Plug into GPA's Motherboard. GPA's quality design includes ● 6-44 pin edge connectors ● +5V, -5V, +12V, -12V external power supply required ● Active termination. The Motherboard, Part No. GPA80, is only $149.95.

TAKE ADVANTAGE OF GPA-EXPANSION CARDS FOR THE GPA80

Memory cards: Now with Fortran compilers available for your TRS-80, additional expansion memory is a must! Card with sockets only, Part No. GPA801, $119.95. Card with 16K of 4116 Dynamic Ram, Part No. GPA802, $224.95. Card with 32K of 4116 Dynamic Ram, Part No. GPA803, $329.95. All cards come equipped with sockets to accomodate 32K of Ram. **EPROM firmware card.** Put those valuable subroutines in firmware. Don't waste time loading and unloading tapes and disks. For 2708 or 2716 EPROMS, Part No. GPA806, $79.95. **Serial I/O card.** Here's what you've been asking for, a full serial terminal interface, with RS-232C or 20 mA. Current loop. Input/output capabilities. Part No. GPA807, $79.95. **Parallel I/O Card.** Control functions in the outside world, monitor and store real time events. Two parallel output ports. Dip switches select ports (0-254). Part No. GPA808, $79.95.

FLOPPY DISK STORAGE BINDER



Three-ring binder comes with ten transparent plastic sleeves which accommodate either twenty, five-inch or ten, eight-inch floppy disks. Binder & 10 holders $14.95 Part No. 8800; Extra holders 95¢ each. Part No. 800.

DIGITAL CASSETTE

5 min. each side. Box of 10 $9.95. Part No. C-5.

DISK JACKET™

Holds two 5-1/4 inch diskettes and will fit any standard three ring binder. $9.95/10 Pack.

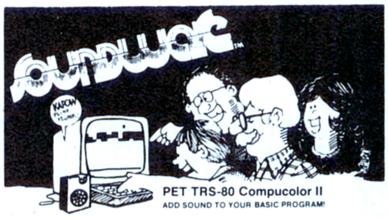
TRENDCOM PRINTER

● 40 characters per second ● 4-7/16 inch wide thermal paper ● Graphics (TRENDCOM 100): 480 sevendot print postions per line. TRENDCOM 100, Part No. TRC0100, $495.95. TRENDCOM 200, Part No. TRC0200, $375.95. **Interface** for TRS-80, Part No. T80A $45.95. For Apple II, Part No. TRCAII, $75.95. For PET, NO. TRCP2, $79.95. For Scoccerer, TRCSR1 $45.95.

SARGON: A Computer Chess Program

Features the complete program that won the 1978 West Coast Computer Faire Tournament. Part No. 00603 — TRS-80 Level II; Part No. 00604 — Apple II (24K). $19.95

SOUND EFFECTS AND MUSIC FOR YOUR COMPUTER



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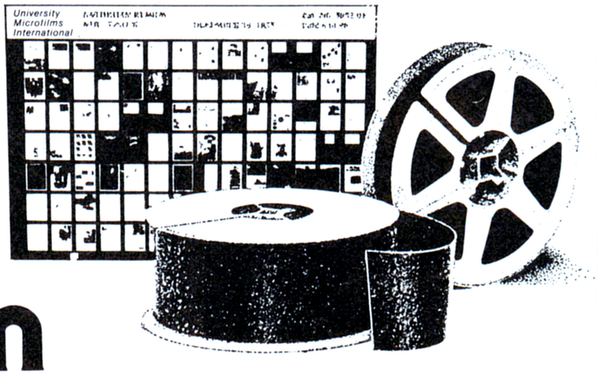

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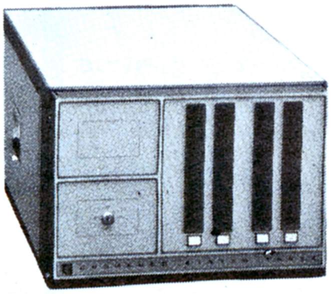

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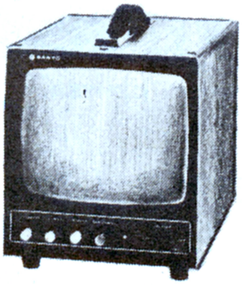

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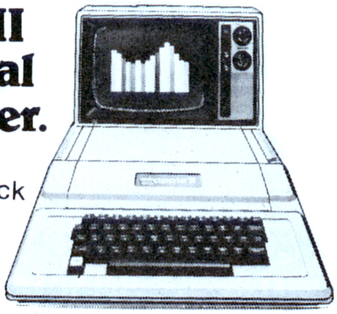

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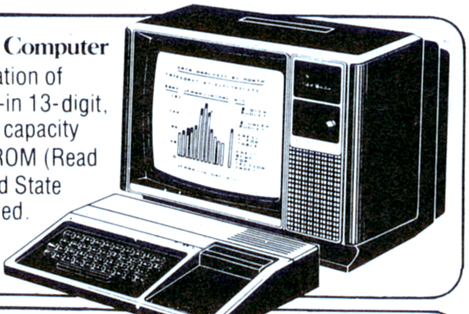

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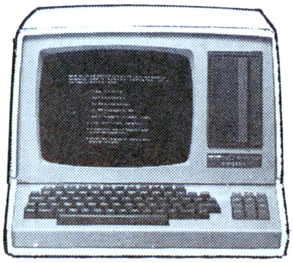

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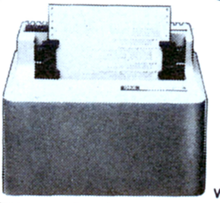

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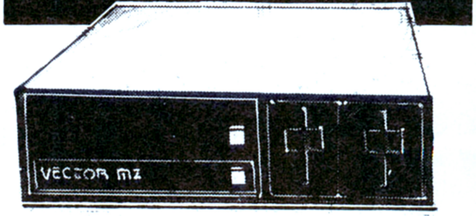

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32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. Not expandable to high resolution Graphics.

Elf II Adapter Kit $24.50

Plugs into Elf II providing Super Elf 44 and 50 pin bus plus S-100 bus expansion (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

1802 16K Dynamic RAM Kit $149.00

1802/S-100 expandable to 32K, Hidden refresh w/clocks up to 4 MHz w/no wait states Addl. 16K RAM **$79.00.**

Quest Super Basic

Quest, the leader in inexpensive 1802 systems announces another first. Quest is the first company worldwide to ship a **full size Basic** for 1802 systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range $\pm .17E^{38}$), 32 bit integer ±2 billion; Multi dim arrays; String arrays; String manipulation; Cassette I/O, Save and load, Basic, Data and machine language programs; and over 75 Statements, Functions and Operators.

Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version.

Super Basic on Cassette	**$40.00**
Tom Pittman's 1802 Tiny Basic Source listing now available. Find out how Tom Pittman wrote Tiny Basic and how to get the most out of it. Never offered before.	**$19.00**
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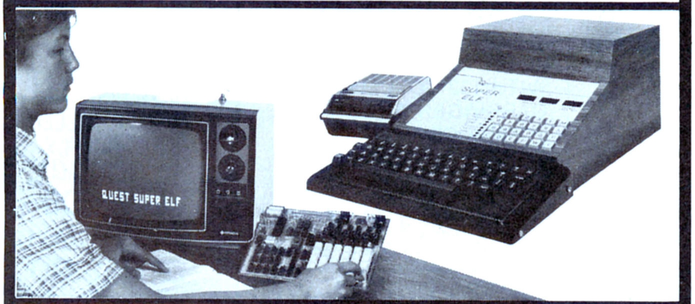

RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R & D.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year. Issues 1-12 bound $16.50.

Tiny Basic Cassette **$10.00,** on ROM **$38.00,** original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

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CD4011	.28
CD4012	.28
CD4013	.39
CD4014	1.00
CD4015	1.00
CD4016	.45
CD4017	1.05
CD4018	.94
CD4019	.45
CD4020	1.02
CD4021	1.25
CD4022	1.10
CD4023	.28
CD4024	.75
CD4025	.28
CD4026	2.00
CD4027	.66
CD4028	.85
CD4029	1.02
CD4030	.45
CD4035	1.02
CD4040	1.02
CD4042	.85
CD4043	.85
CD4044	.85
CD4046	1.67
CD4049	.45
CD4050	.49
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	.40
CD4069	.40
CD4070	.50
CD4071	.28
CD4072	.28
CD4073	.28
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CD4076	1.45
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CD4081	.28
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CD4585	1.10
CD40192	3.00
74C00	.28
74C04	.40
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74C14	2.10
74C20	.28
74C30	.28
74C48	1.95
74C74	.75
74C76	1.40
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8097	.65
8098	.65
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8T23	3.10
8T24	3.50
8T25	3.20
8T26	1.69
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MOS/MEMORY RAM

2101-1	3.95
2102-1	.95
2102AL-4	1.25
2102AN-2L	1.60
21L02-1	1.18
2104A-4	4.95
2107B-6	3.75
2111-1	3.75
2112-2	3.95
2114L 300ns	7.40
4116 200ns	9.50
8/4116 200ns	64.00
2513B	6.30
MM5262	.40
MM5280	3.00
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MM5330	5.94
PD411D-3	4.00
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MM5369	2.10
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8085	27.00
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Z80A	19.75
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8214	8.00
8216	2.90
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N82S23	2.95
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N82S131	3.75
N82S136	8.75
N82S137	8.75
DM8577	2.90
8223	2.90
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44 pin edge	2.75
100 pin edge	4.50
100 pin edge WW	5.25

IC SOCKETS

Solder Tin Low Profile			
PIN	1 UP	PIN	1UP
8	.15	22	.30
14	.14	24	.35
16	.16	28	.42
18	.27	36	.58
20	.29	40	.57

2 level 14 pin ww .20

WIRE WRAP LEVEL 3

PIN		PIN	
14	.32	24	.86
16	.33	28	1.00
18	.57	40	1.23

CRYSTALS

1 MHz	4.50
2 MHz	4.50
4 MHz	4.25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3.90
32768 Hz	4.00
1.8432 MHz	4.50
3.5795 MHz	1.20
2.0100 MHz	1.95
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10 per type .03	1000 per type .012
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½ watt 5% per type .05

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DL707/DL707R	CA	.300	1.00
DL727/728	CA/CC	.500	1.90
DL747/750	CA/CC	.600	1.95
DL750	CC	.600	1.95
FND359	CC	.357	.70
FND500/507	CC/CA	.500	1.35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	.800	2.20
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4 digit Bubble			.80
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DG10 Fluorescent			1.75
5 digit 14 pin display			1.00
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7520 Clairex photocells			.39
TIL311 Hex			9.50
MAN3640	CC	.30	1.10
MAN4610	CA	.40	1.20
MAN4640	CC	.40	1.20
MAN4710	CA	.40	.95
MAN4740	CC	.40	1.20
MAN6640	CC	.56	2.95
MAN6710	CA	.60	1.35
MAN6740	CC	.60	1.35

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32K Static RAM Kit	475.00
16K Dynamic RAM Kit	199.00
32K Dynamic RAM Kit	310.00
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- S-100 COMPATIBLE
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16 PIN	.12	.11
18 PIN	.16	.14
20 PIN	.24	.22
24 PIN	.31	.29
28 PIN	.35	.31
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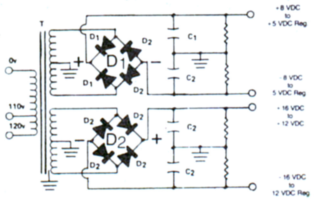

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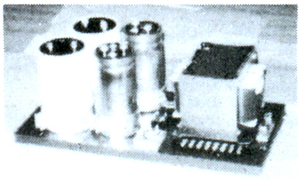

POWER TRANSFORMERS (WITH MOUNTING BRACKETS)

ITEM NO.	USED IN KIT NO.	PRI. WINDING TAPS	SECONDARY WINDING OUTPUTS 2×8 Vac	2×14 Vac	2×24 Vac	SIZE W × D × H	UNIT PRICE
T_1	1	0V, 110V, 120V	2×7.5A	2×2.5A	———	3¾''×3⅝''×3⅛''	21.95
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T_3	3	0V, 110V, 120V	2×9A	2×2.5A	2×2.5A	3¾''×4⅜''×3⅛''	29.95
T_4	4	0V, 110V, 120V	2×4A	———	2×3A	3¾''×3⅝''×3⅛''	21.95

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ITEM	USED FOR	@+8 Vdc	@−8 Vdc	@+16 Vdc	@−16 Vdc	@+28 Vdc	SIZE W×D×H	UNIT PRICE
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KIT 2	SYSTEM SOURCE	25A	———	3A	3A	———	12''×6''×4⅞''	58.95
KIT 3	DISC SYSTEM	15A	1A	2A	2A	4A	14''×6''×4⅞''	66.95
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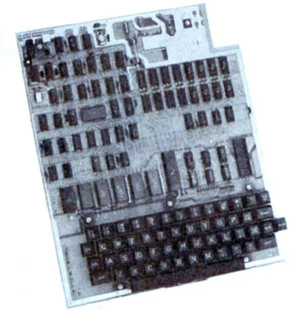

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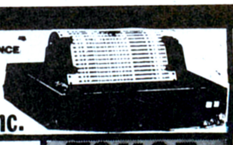

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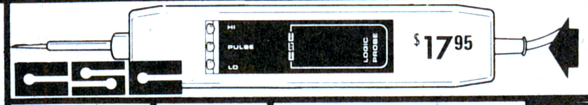

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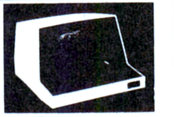

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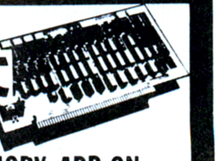

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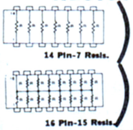

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27011	VDB-8024 Video Display Board Kit	370
27012	ExpandoRAM II Expandable RAM Board Kit (16K RAM)	460
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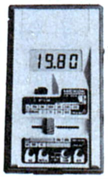

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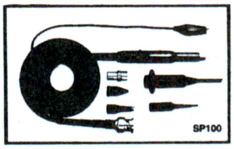

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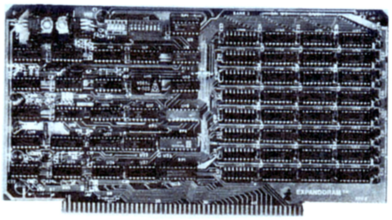
The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the invisible on-board refresh, and IT WORKS!

- Bank Selectable
- Phantom
- Power 8VDC, +16VDC, 5 Watts
- Lowest Cost Per Bit
- Uses Major Brand 16K RAMS
- PC Board is doubled solder masked and has silk-screened parts layout
- Extensive documentation clearly written



- Complete kit includes all Sockets for 64K
- Memory access time: 375ns, Cycle time: 500ns.
- No wait states required
- 16K boundaries and Protection, via Dip Switches
- Designed to work with Z-80, 8080, 8085 CPU's

EXPANDORAM 64K Kit (16K Ram)

16K	$239.95
32K	309.95
48K	379.95
64K	449.95

SD'S PROM 100 PROM Programmer Board

The PROM-100 Programmer is a development tool for S-100 Bus computer systems. The Zero Insertion Force Programming Socket extends above the card cage height for easy access to PROM devices. Software verifies PROM erasure, verifies program loading and provides for reading of object file from Disk or PROM and programming into PROM/EPROM. Features include: On-board generated 25vdc Programming pulse, TTL compatible, maximum programming time for 16,389 bits is 100 seconds. Programs: 2708, Intel 2758, 2716, 2732 and TI 2516. DIP Selectable EPROM type.

PROM-100 Board Kit $149.95

SD'S SBC-200 SINGLE BOARD COMPUTER Kit $289.95

S-100 Bus compatible and based on the powerful Z80 microprocessor, the SBC-200 meets the needs of a Z-80 CPU board with many additional features. Ideal for Industrial and control applications. All of the same features that have made the SBC-100 famous, PLUS 4MHz OPERATION. ● S-100 Bus Compatible ● Z80 Central Processing Unit ● 1024 Bytes of Random Access Memory ● 8K Bytes of PROM using 2716 ● Serial Input/Output Port (with Asynchronous and Synchronous Operation) ● Parallel Input and Output Ports ● Four Channel Counter/Timer (Z80-CTC) ● Software Programmable Baud Rate Generator ● No-Front Panel Required for Operation ● 4 MHz Operation.

SD'S VERSAFLOPPY II

● IBM 3740 Compatible Soft Sectored Format for Single Density Drives ● Operates with Single and Dual Sided Drives, Single or Double Density Drives and 5" & 8" Drives — in any combination of four simultaneously ● Drive Select and Side Select Circuitry ● S-100 Bus Compatible ● Vectored Interrupt Operation Optional ● Phase Locked Loop Data Recovery Circuit ● Operates with Z80 CPU's ● Uses FD1791-1 Controller Chip ● Ther Versafloppy II incorporates all the possible features of a flexible disk drive controller into one board. Capable of handling four drives simultaneously, combinations of any variety are possible, such as 5" single sided, 8" dual density dual sided, 5" dual density single sided. Most popular drives are controlled directly with the Versafloppy II. The operating system for the Versafloppy II is the extremely powerful SDOS available for SD Systems. Diagnostic and control software available to complete your disk system.

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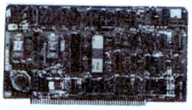

SD'S VDB-8024 VIDEO DISPLAY BOARD

The VDB-8024 features its own on-board Z80 microprocessor. This gives the capability of using software (included in ROM) to control functions and enhancements without interference with the computer's CPU. Included in the special features: 80 characters by 24 lines display, keyboard power and interface, composite and separate video output, 2K on-board RAM, a total of 256 available characters, full cursor control, forward and reverse scrolling, underlining, field reverse, field protect enhancements, programmable characters.

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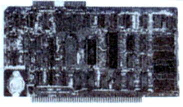

SD'S SBC-100 SINGLE BOARD COMPUTER

The SBC-100 provides a complete micro-computer on a single board! The Z80 microprocessor is used as the heart of the SBC-100. The SBC-100 meets all the requirements of a Z80 CPU board with the added features of I/O ports, counter/timer channels, on board RAM, provisions for PROM/ROM and a software programmable baud rate generator. S-100 Bus compatible, the SBC-100 features are: 8K bytes of available PROM, 1024 bytes on-board RAM, Serial I/O with both synchronous and asynchronous operation, Parallel I/O ports, Operational Vectored Interrupts, and Four Counter/Timer Channels. SD Monitor available for RS-232 and Video Terminals. Disk based system software also available.

SBC-100 KIT $249.95

TARBELL FLOPPY DISK INTERFACE

Compatible with Z80 & 8080. S-100 Bus. Uses CPM operating system. Plugs directly into your IMSAI or ALTAIR ● Fastest transfer rate

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Operates at 2 MHZ or 4 MHZ by DIP switch selection and includes two sockets for 2716 or 2732 EPROMs or TMS 4016 2K RAMs. Jumper options generate the new IEEE S-100 signals.

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● 80 char. per line, up to 51 lines ● Graphics up to 160 × 204 matrix ● Up to 256 user defined symbols (optional EPROM) ● Composite video

PB1 2708/2716 Programmer & 4K/8K EPROMBoard Kit $124.00

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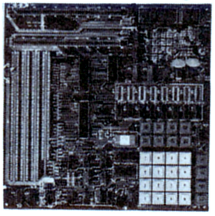
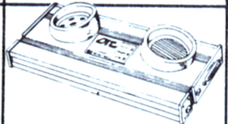
Kit: $279.95 Assembled & Tested $349.95

SD System's Z80 Starter Kit enables the novice to build a complete microcomputer on a single board. Featuring the powerful Z80 microprocessor, the Z80 Starter Kit features ● Keyboard and Display ● Audio Interface ● PROM Programmer ● Expansion and Wire Wrap Area ● On Board RAM ● 4 Channel Counter/Timer ● Z-BUG Monitor in PROM ● I/O Ports.





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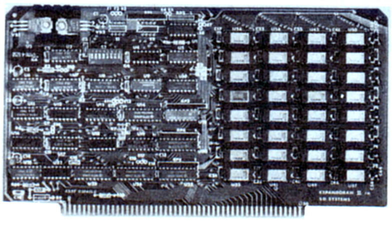
VB1B VIDEO BOARD KIT $124.00

● S-100 bus ● 64 or 32 characters per line (DIP switch selectable), 16 lines ● Graphics 128×48 matrix ● Upper case, lower case, Greek characters, symbols and numbers ● 7×9 dot character matrix ● Black-on-white or white-on-black ● Timing 60Hz vertical rate, 16.2KHz horizontal rate, Crystal 12.44MHz ● Parallel and composite video output (US TV signals), separate video, horizontal and vertical sync

SD'S EXPANDORAM II
The Randem Access Memory

- S-100 Bus Compatible
- Up to 4Mhz Operation
- Expandable Memory from 16K to 256K
- DIP Switch Selectable Boundaries
- Uses 16K (4116) or 64K (4164) Memory Devices
- Page Mode Operation Allows up to 8 Memory Boards on Bus
- Operates with Z80 CPU's
- Phantom Output Disable
- Invisible Refresh (Synchronized with Wait States)



SD Systems' ExpandoRAM II is a dynamic RAM board with capacities from 16K bytes (4116) to 256K bytes (4164). It operates on the industry S-100 Bus. The design allows 8 boards to operate from the same S-100 Bus. The ExpandoRAM II is compatible with most S-100 CPU's based on the Z80 microprocessor.

EXPANDORAM II KIT

16K	$295.95
32K	369.95
48K	444.95
64K	519.95

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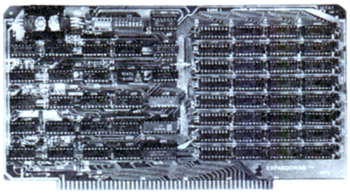

EXPANDORAM

Expandable to 64K Using 4116 RAMS

Interfaces with most popular S-100 boards
Bank selectable; PHANTOM provision
Draws only 5 watts fully populated
Designed to work with Z-80, 8080, and 8085 systems
No wait states required
16K boundaries & protect via dip switches
Kits come with sockets for full 64K
Invisible refresh

MEM-64133K 64 K KIT	**$399.95**
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MEM-16130K 16K KIT	**$204.95**
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Sale Price $475.00

32K STATIC RAM

Expandable 8K/32K, 2/4MHz, KIT/A&T

Switchable 2 or 4 MHz

THE JADE BIG Z

Z-80A CPU with Serial I/O Port

This CPU can accomodate a 2708, 2716, or 2732 EPROM in SHADOW mode, allowing you to use a full 64K of RAM. The MWRITE signal is generated automatically if you use the board without a front panel. There's also an independent on-board USART to control the RS232 serial port at baud rates from 75 to 19,200.

We've sold thousands of these high quality S-100 CPU boards at $159.95; **but now,** in a brief fit of financial insanity, we're offering them to you for only $135.00! **Don't pass this one up!**

CPU-30201K (KIT)	**$135.00**
CPU-30201A (A&T)	**$199.00**
CPU-30200B (BARE BOARD)	**$35.00**

S D Systems

EXPANDORAM II

4 MHz RAM Board Expandable to 256K

S-100 bus compatible, up to **4 MHz** operation
Expandable memory from 16K to 256K
Dip switch selectable boundaries
Page-mode allows up to 8 boards on the same bus
Invisible refresh; PHANTOM output disable
Designed to operate in Z-80 based systems

MEM-64633K 64K KIT	**$509.95**
MEM-64633A 64K A&T	**$559.95**
MEM-48632K 48K KIT	**$439.95**
MEM-48632A 48K A&T	**$489.95**
MEM-32630K 32K KIT	**$359.95**
MEM-32630A 32K A&T	**$409.95**
MEM-16630K 16K KIT	**$279.95**
MEM-16630A 16K A&T	**$329.95**

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PB-1

EPROM Programmer for 2708 or 2716

MEM-99510K (KIT)	**$125.00**
MEM-99510A (A&T)	**$175.00**

JADE DOUBLE-D

Double Density Disk Controller

Read/write single or **double density,** 8″ or 5¼″ drives
On board Z-80 insures reliable operation
CP/M compatible in either single or double density
Density is software selectable
Up to 4 single or double sided, single or double density drives may be mixed on the same system
EIA level serial printer interface on board-up to 9600 baud (perfect for despooling operations)
All the hard work of disk access is done by the on board Z-80A and 2K memory, leaving your host CPU free for its normal duties
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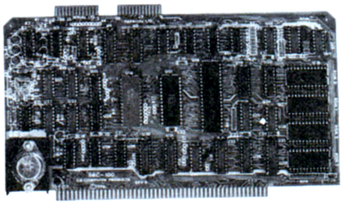

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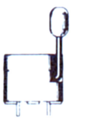

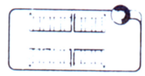

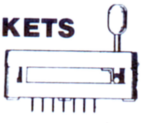

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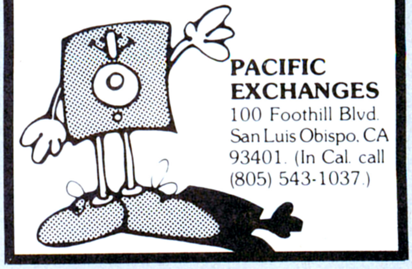

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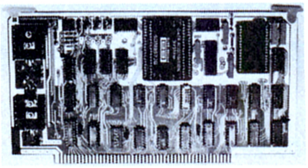

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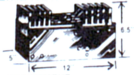

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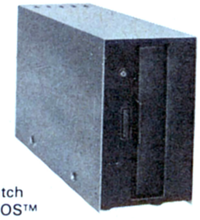

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10280	25/50 S/E TRS 80	.140	4.50	4.05	3.60
10175	20/40 S/E TRS 80	.140	5.85	5.35	4.75
10180	20/40 W/W TRS 80	.200	3.30	3.00	2.15
10190	20/40 S/T TRS 80	.140	3.20	2.90	2.55
10485	36/72 S/E Vector	.140	5.50	4.90	4.40
10490	36/72 W/E Vector	.200	5.80	5.25	4.65
10500	36/72 S/T Vector	.140	5.70	4.20	4.60
10535	40/80 S/E PET	.140	5.85	5.35	4.75
10540	40/80 W/W PET	.200	6.00	5.40	4.80
10550	40/80 S/T PET	.140	5.80	5.25	4.65
10585	43/86 S/E COS/ELF	.140	6.95	6.25	5.55
10605	43/86 S/T COS/ELF	.140	6.60	5.95	5.30
10595	43/86 W/W COS/ELF	.200	6.90	6.20	5.95
10615	43/86 S/T COS/ELF	.200	6.80	6.10	5.40

.156" CONTACT CENTER CONNECTORS.

PART #	DESCRIPTION.	Row Sp.	1-9pc.	10-24pcs.	25pcs. Up.
15105	6/12 S/E PET/NSC	.140	$1.80	$1.65	$1.45
15110	6/12 S/T PET/NSC	.140	1.85	1.65	1.50
15137	6/12 S/T PET/NSC	.200	1.80	1.54	1.45
15175	6/- S/E Sgle Row	- -	1.70	1.50	1.30
15270	10/20 S/E	.140	2.15	1.95	1.70
15275	10/20 S/T	.140	2.00	1.85	1.60
15435	12/24 S/E PET	.140	2.60	2.35	2.10
15440	12/24 S/T PET	.140	2.65	2.40	2.15
15445	12/24 S/T PET	.200	2.75	2.50	2.20
15505	15/30 S/E GRI Key	.140	2.50	2.25	2.00
15510	15/30 S/T GRI Key	.140	2.40	2.15	2.95
15515	15/30 W/W GRI Key	.200	2.60	2.35	2.10
15600	18/36 S/E	.140	3.35	3.05	2.70
15610	18/36 S/T	.140	3.00	2.70	2.40
15615	18/36 W/W	.200	3.60	3.20	2.90
15700	22/44 S/E KIM/VEC	.140	2.98	2.90	2.75
15705	22/44 S/T KIM/VEC	.140	3.98	3.30	3.00
15710	22/44 W/W KIM/VEC	.200	3.49	3.20	2.85
15875	25/50 S/E	.140	4.65	4.20	3.75
15880	25/50 S/T	.140	4.55	4.10	3.65
15885	25/50 W/W	.200	4.85	4.35	3.90
16115	36/72 S/E	.140	6.50	5.85	5.20
16120	36/72 S/T	.140	6.55	5.90	5.25
16125	36/72 W/W	.200	6.75	6.10	5.40
16145	36/72 S/T	.200	6.50	5.85	5.20
16235	43/86 S/T Mot 6800	.140	6.60	5.95	5.30
16240	43/86 W/W Mot 6800	.200	7.80	7.05	6.25
16260	43/86 S/T Mot 6800	.200	6.50	5.85	5.20
16725	43/86 S/E Mot 6800	.140	7.20	6.50	5.75
K-1	Pol-Keys		.15	.12	.10

'D' TYPE SUBMINIATURE CONNECTORS.

PART NUMBER		DESCRIPTION.	QUANTITY 1-9pcs.	10-24pcs.	25-99pcs.
DE	9P	Male	$1.60ea.	$1.40ea.	$1.30ea.
DE	9S	Female	2.25ea.	2.00ea.	1.90ea.
DE	110963-1	2 pc. Grey Hood.	1.50ea.	1.35ea.	1.20ea.
DA	15P	Male	2.35ea.	2.15ea.	2.00ea.
DA	15S	Female	3.25ea.	3.10ea.	2.90ea.
DA	51211-1	1. pc. Grey Hood	1.40ea.	1.20ea.	1.15ea.
DA	51226-1	2 pc. Black Hood	2.50ea.	2.25ea.	2.00ea.
DA	110963-2	2 pc. Grey Hood	1.60ea.	1.35ea.	1.30ea.
DB	25P	Male	2.80ea.	2.60ea.	2.40ea.
DB	25S	Female	3.60ea.	3.40ea.	3.20ea.
DB	51212-1	1 pc. Grey Hood	1.50ea.	1.30ea.	1.10ea.
DB	51226-1	2 pc. Black Hood	1.90ea.	1.65ea.	1.45ea.
DB	110963-3	2 pc. Grey Hood	1.75ea.	1.50ea.	1.35ea.
DC	37P	Male	4.20ea.	4.00ea.	3.70ea.
DC	37S	Female	6.00ea.	5.75ea.	5.50ea.
DC	110963-4	2 pc. Grey Hood	2.25ea.	2.00ea.	1.75ea.
DD	50P	Male	5.50ea.	5.10ea.	4.75ea.
DD	50S	Female	9.40ea.	8.60ea.	8.00ea.
DD	51216-1	1 pc. Grey Hood	2.40ea.	2.20ea.	2. 00ea.
DD	110963-5	2 pc. Grey Hood	2.60ea.	2.40ea.	2.10ea.
D	20418-2	Hardware Set (1 Hood Set)	.90ea.	.80ea.	.70ea.

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14 pin	$0.40 ea.
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$5.00 ea.

EIA 8 CONDUCTOR CABLES 8ft. Long.
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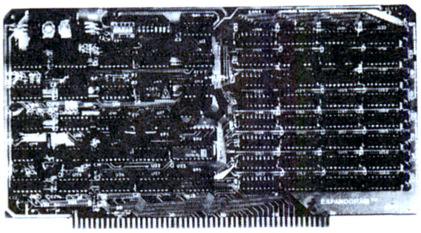
EXPANDABLE TO 64K USING 4116 RAMS



- Interfaces with most popular S-100 boards
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- No wait states required
- 16K boundaries & protect via dip switches
- Kits come with sockets for full 64K
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MEM-16K (16K KIT)	$239.95
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MEM-32AT (32K A&T)	$359.95
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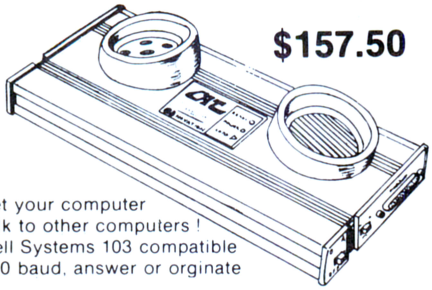

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2716 (5 VOLT)	$24.00
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2532	$70.00
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NEW DISK OPERATING SYSTEM

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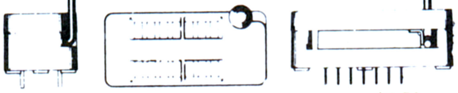
SDOS is a CP/M compatible operating system designed for the S D Sales Versafloppy I or II. It requires the SBC-100/Versafloppy board set and functions as a superset of CP/M giving 19 additional functions including the attributes, disk label and read/write logical blocks. It provides additional protection features and is expandable to a multi-user real time system. **$200.00**

TI PRINTERS

TI810 PARALLEL	$1895.00
TI810 SERIAL	$1695.00

TEXTOOL ZIP* DIP II SOCKETS



16 PIN ZIP* DIP II	$5.50
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CP/M 2.0

Digital Research has done it again! This new release of their industry standard disk operating system is bound to be an even bigger hit than the original version. All of the fundamental file-size restrictions of release 1 have been eliminated, while maintaining full compatibility with the earlier versions. This new release can be field-configured by the user for a single mini-disk up through a multiple drive hard-disk system with 128 megabyte capacity. Field configuration can be accomplished easily through use of the Macro Library (DISKDEF) provided with CP/M 2.0.

A powerful operating system for only ... **$150.00**

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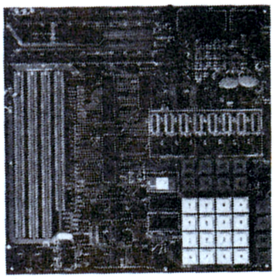
S D SYSTEMS

Z-80 STARTER KIT

COMPLETE Z-80 MICROCOMPUTER



- On-board keyboard, display, EPROM programmer, and cassette interface
- On-board S-100 interface
- Wire-wrap area and room for 2 S-100 connectors
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Z-80K (KIT)	$279.95
Z-80AT (A&T)	$349.95

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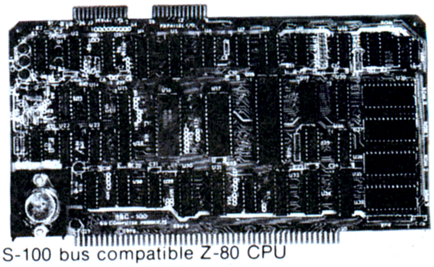
OR 4 MHz SINGLE BOARD COMPUTER



- S-100 bus compatible Z-80 CPU
- 1K of on-board RAM
- 4 EPROM sockets accomodates 2708, 2716, or 2732
- One parallel and one serial I/O port
- 4-channel counter timer chip (Z-80 CTC)
- Software programmable serial baud rates

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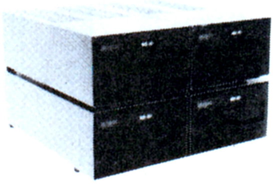
SBC-100AT (2 MHz A&T)	$299.95
SBC-200K (4 MHz KIT)	$289.95
SBC-200AT (4 MHz A&T)	$339.95



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S-100

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S D SYSTEMS

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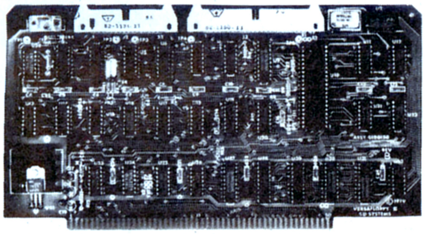
DOUBLE DENSITY DISK CONTROLLER



Single or double density floppy disk controller
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259840 bytes on double sided 5¼" diskettes
S-100 bus (IEEE) standard compatible
IBM 3740 format in single density
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Operates with Z-80, 8080, and 8085 CPU's
Controls up to 4 drives
Vectored interrupt operation optional

VF-2K (KIT)	**$335.95**
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APPLE KITS & ASSEMBLED BOARDS

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- Blinking/blank fields
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- Underlining
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- Function/editing keys
- Blinking cursor
- Typewriter/TTV keyboards
- Numeric pad
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8243	$ 5.00
8251	$ 7.00
8253	$19.00
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8259	$19.95
8275	$69.95
8279	$17.50
8295	$16.50

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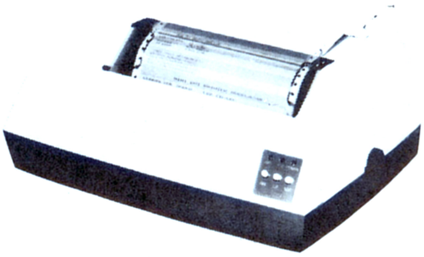

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VB2 I/O Mapped Video Interface	**$29.95**
I02 Parallel I/O Interface	**$34.00**
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SB1 Music Synthesizer	**$39.95**
OB1 Vector Jump & Prototyping Board	**$29.95**
MB6B 8K Static RAM	**$25.95**
MB7 Low Power 16K Static RAM	**$26.95**
MB8 4K 1702 EPROM Board	**$29.95**
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XB1 Extender Board	**$13.50**

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AIO Apple Pascal Patcher Disk	**$25.00**
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Paper Tape of MUS-X1 Interpreter	**$ 9.00**
CP/M Compatible 8" Disk, containing • MUS-X1 Music Interpreter • Test Program • 18 Encoded Music Selections	**$25.00**
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SB1 Music Synthesizer Manual	**$10.00**
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Card Guides	**$ .15**

S-100 KITS & ASSEMBLED BOARDS

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Assembled & Tested	**$250.00**
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Kit	**$125.00**
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Kit	**$199.00**
Assembled & Tested	**$279.00**
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Kit	**$ 55.00**
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450 ns RAM	
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Assembled & Tested	**$224.95**
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Kit - without EPROMs	**$ 65.00**
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T1 Active Terminator	
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32K-Keyboard N	$1,295

B — large keyboard (graphics not on keys)
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TNW Bi-Dir.RS-232 printer S-face	$229.00
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Micromodem	$379
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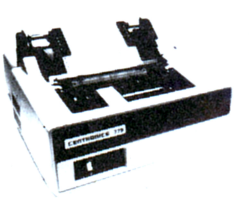

The 779-2 is a tractor feed printer designed for small business systems. Uses a 5x7 dot matrix to produce all 64 upper case ASCII characters. Centronics is the biggest name in printers and this is their most popular model.

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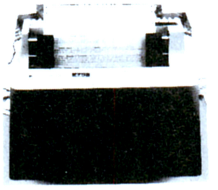

Standard features include: 4 character 8.3 to 16.5 cpi • 56 cps at 10 char. per in. • Selectable line spacing • 8 switch-selectable form sizes.

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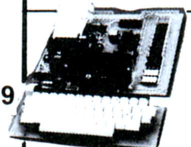

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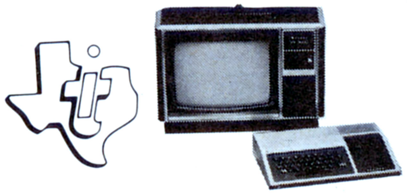

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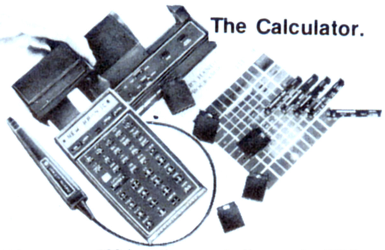

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74LS08	.35	74LS75	.71	74LS162	1.25
74LS09	.42	74LS76	.54	74LS163	1.39
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74LS11	.75	74LS83	1.05	74LS175	1.25
74LS13	.59	74LS85	1.50	74LS181	2.49
74LS14	1.25	74LS86	.54	74LS190	1.39
74LS15	.35	74LS90	.71	74LS191	1.39
74LS20	.35	74LS92	.90	74LS192	1.39
74LS21	.35	74LS93	.90	74LS193	1.39
74LS22	.35	74LS95	.99	74LS194	1.39
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74LS30	.35	74LS112	.54	74LS258	1.75
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Z80-4MHz Single Card Computer

Cromemco's Single Card Computer is a complete computer which brings the power of the Z-80 and the flexibility of the S-100 bus to the dedicated computer environment.

The card offers 4 MHz operation, 8K bytes of on-board 2716 PROM, and 1K byte of static RAM memory. This stand-alone card also provides an RS-232 (or 20mA current loop) serial interface with programmable baud rates to 76,800, vectored interrupts, 24 bits of bidirectional parallel I/O, and 5 programmable timers. Only a power supply and PROM software are required for operation. The Single Card Computer is assembled and tested (Model SCC-W) for $450. The Monitor and Control BASIC are available in two ROM's (Model MCB-216) for $90.

SCC-W (Assembled) **$450.00**

Processor: 4MHz Z-80
Instruction Set: 158 instructions incl. the 78 instructions of the 8080.
ROM Capacity: 8K Bytes located from address 0000 to 1FFF.
ROM Type: Intel 2716 PROM or equivalent.
RAM Capacity: 1K Bytes located from address 2000 to 23FF
RAM Type: 4045, Static

Serial I/O Ports:
I/O Levels: RS-232 or 20mA current loop
Baud Rates: 110 to 76,800 (software selectable)
Parallel Ports:
Input Port: 24 bits bidirectional
Output Port: 24 bits bidirectional
Input Load: One TTL equivalent
Output Drive: 20 TTL loads
Interval Timers:
Number of timers: 5

Timer range: 0-16.32 milliseconds (software sel.)
Timer resolution: 64 microseconds
Vectored Interrupts:
No. of restart locations (Z-80 mode): 65,536
General Information:
UART type: 5501 Bus: S-100
Power requirements: +8V at 1.4A
+18V at 70mA
−18V at 25mA
Operating environment: 0-55°C

DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1	XC111R	.190"	red	5/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1	XC111G	.190"	green	4/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1	XC111Y	.190"	yellow	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1	XC111C	.190"	clear	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1				
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1				
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1				
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1				

INFRA-RED LED
¼"x ¼"x 1/16" flat 5/$1

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.75	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.49	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.49	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	.99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1.50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	1.50
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	3.25	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	1.25	CA3401N	.59
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7-seg. LED driver	1.50
MM5309	4.95

CLOCK CHIPS

MM5309	4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998a	4.95
CT 7001	6.95

MOTOROLA

MC1408L7	4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	50 PCS	$1.75
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	50 PCS	1.75
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50 PCS	1.75
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	50 PCS	1.75
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50 PCS	1.75

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5-80

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AY-5-9100	Push Button Telephone Dialler	$14.95
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HD0165	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	7.95
74C923	Keyboard Encoder (20 keys)	6.25

ICM CHIPS

ICM7045	CMOS Precision Timer	24.95
ICM7205	CMOS LED Stopwatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

NMOS READ ONLY MEMORIES

MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
MCM6574	128 X 9 X 7 Math Symbol & Pictures	13.50
MCM6575	128 X 9 X 7 Alpha Control Char Gen	13.50

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.95
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block **(Special)**	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set
MC14433P	3½ Digit A/D Converter	13.95

LITRONIX ISO-LIT 1
Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)
49¢ each

SN 76477
SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
$3.95 each

TV GAME CHIP AND CRYSTAL
AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc. **7.95/set**

EXAR

XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55			XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	3.95
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00
1N751	5.1	400m	4/1.00
1N752	5.6	400m	4/1.00
1N753	6.2	400m	4/1.00
1N754	6.8	400m	4/1.00
1N757	9.0	400m	4/1.00
1N759	12.0	400m	4/1.00
1N959	8.2	400m	4/1.00
1N965	15	400m	4/1.00
1N5232	5.6	500m	28
1N5234	6.2	500m	28
1N5235	6.8	500m	28
1N5236	7.5	500m	28
1N5242	12	500m	28
1N5245	15	500m	28
1N456	25	40m	6/1.00
1N458	150	7m	6/1.00
1N485A	180	10m	5/1.00
1N4001	50 PIV	1 AMP	12/1.00

TYPE	VOLTS	W	PRICE
1N4002	100 PIV	1 AMP	12/1.00
1N4003	200 PIV	1 AMP	12/1.00
1N4004	400 PIV	1 AMP	12/1.00
1N4005	600 PIV	1 AMP	10/1.00
1N4006	800 PIV	1 AMP	10/1.00
1N4007	1000 PIV	1 AMP	10/1.00
1N3600	50	200m	6/1.00
1N4148	75	10m	15/1.00
1N4154	35	10m	12/1.00
1N4733	5.1	1w	28
1N4734	5.6	1w	28
1N4735	6.2	1w	28
1N4736	6.8	1w	28
1N4738	8.2	1w	28
1N4742	12	1w	28
1N4744	15	1w	28
1N1183	50 PIV	35 AMP	1.60
1N1184	100 PIV	35 AMP	1.70
1N1185	150 PIV	35 AMP	1.70
1N1186	200 PIV	35 AMP	1.80
1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C36M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
		2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100 +		1-9	10-99	100 +
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1/35V	.39	.31	.25	1.5/35V	.41	.33	.26
.15/35V	.39	.31	.25	2.2/35V	.51	.41	.33
.22/35V	.39	.31	.25	3.3/25V	.53	.43	.34
.33/35V	.39	.31	.25	4.7/25V	.63	.51	.41
.47/35V	.39	.31	.25	6.8/25V	.79	.63	.50
.68/35V	.39	.31	.25	15/25V	1.39	1.12	.89
1.0/35V	.39	.31	.25	22/6V	.79	.63	.50

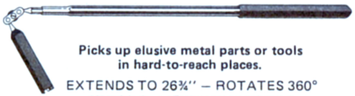
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

MINIATURE SCREWDRIVER

RUGGED CONSTRUCTION
1000's OF USES – 1/8" TIP .... 2/$1.00

MAGNETIC RETRIEVER TOOL



Picks up elusive metal parts or tools in hard-to-reach places.

EXTENDS TO 26¾" – ROTATES 360°
STRONG, LIFETIME MAGNET

MRT-2281 .... $3.95

CONTINENTAL SPECIALTIES

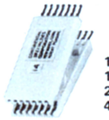
LOGIC PROBE KIT

SPECIFICATIONS

Input Impedance: 300,000 Ohms.
Thresholds: "Lo" 30%Vcc – "Hi" 70%Vcc
Maximum Speed: 300 nsec., 1.5MHz
Input Protection: ±50VDC continuous 117VAC for 15 sec.
Power: 30mA @5V – 40mA @ 15V – 25V max. reverse voltage protected; 36" cable with color coded clips included.
Operating Temp.: 0-50°C.
Dimensions: 5.8L x 1.0W x 0.7D in. (147 x 25 x 18mm)
Weight: 30 oz. (85 gm)

LPK-1 .... $21.95/Kit

Proto Clips



14-PIN CLIP	PC-14	$ 4.50
16-PIN CLIP	PC-16	$ 4.75
24-PIN CLIP	PC-24	$10.00
40-PIN CLIP	PC-40	$16.00

Proto Boards

PB-6	$17.95
PB-100	19.95
PB-101	22.95
PB-102	26.95
PB-103	44.95
PB-104	55.95
PB-203	99.95
PB-203A	155.00
PB-203A-Kit	131.00

Jumbo 6-Digit Clock Kit

- ★ Four .630"ht. and two .300"ht. common anode displays
- ★ Uses MM5314 clock chip
- ★ Switches for hours, minutes and hold functions
- ★ Hours easily viewable to 30 feet
- ★ Simulated walnut case
- ★ 115VAC operation
- ★ 12 or 24 hour operation
- ★ Includes all components, case and wall transformer
- ★ Size: 6¾ x 3⅛ x 1¾

JE747 .... $29.95

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

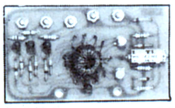
JE701

6-Digit Clock Kit $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200....... $14.95



ADAPTER BOARD
—Adapts to JE200—
±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... $12.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
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8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. 1/0 (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. 1/0 (PPI)	9.95
8257	Prog. DMA Control	19.95
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6800/6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$13.95
Z80A(780-1)	CPU	15.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

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MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49

UART'S		
A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS		
M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

ROM'S		
2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
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7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
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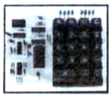
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S			
1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516 (2716)	16K*	EPROM	39.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

JE600 HEXADECIMAL ENCODER KIT



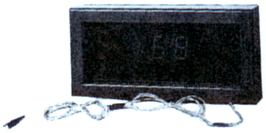
FEATURES:
- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bistable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin 1C connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 .... $59.95
Hexadecimal Keypad only $14.95

DIGITAL THERMOMETER KIT



- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 .... $39.95

62-Key ASCII Encoded Keyboard Kit

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- Easy interfacing with a 16-pin dip or 18-pin edge connector

The JE610 62-Key ASCII Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10mA for operation.

JE610 ..... $79.95
62-Key Keyboard only . . $34.95

HICKOK LX303 Portable LCD Digital Multimeter

- Big ½ inch high, 3½ Digit Liquid Crystal Display
- Over 200 Hours of operation with a 9V battery
- Automatic zero, polarity and overrange indication
- 100mV DC F.S. sensitivity
- 1% basic accuracy
- 19 ranges and functions
- Rugged Cycolac® case and removable cover, stores test lead set.
- Full one year warranty.

SPECIFICATIONS: DC volts (5 ranges): 0.1mV to 1000V; Accuracy ±0.5% rdg ±0.5% f.s.; Input imped: 10MΩ; Max. input 1kV except 500V on 200mV range.
AC Volts (40Hz to 5kHz): 0.1V to 600V; Accuracy: ±1.0% rdg ±0.5% f.s. (–2dB max. at 5kHz); Max. input: 600V.
Resistance (6 Low Power Ranges): 0.1 to 20MΩ; Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range); input protected to 120VAC all ranges.
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Dimensions and Weight: 5-7/8" x 3-3/8" x 1-3/4", 8 oz.; POWER: 9V battery (not included) or Hickok AC adapter; READ RATE: 3/sec.

LX303 Digital Multimeter $74.95

PART NO.	DESCRIPTION	PRICE
RC-3	115V AC ADAPTER	7.50
CC-3	PADDED CARRYING CASE	7.50
VP-10	X10 DC PROBE ADAPTER (Up to 10K)	14.95
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5-80

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method .....Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate ....300 Baud.
Data Format ....Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies ...2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies ..Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity ....–46 dbm accoustically coupled.
Transmit Level ....–15 dbm nominal. Adjustable from –6 dbm to –20 dbm.
Receive Frequency Tolerance ...Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface ....EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements ....120 VAC, single phase, 10 Watts.
Physical ....All components mount on a single 5" by 9" printed circuit board. All components included.

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Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
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- ★ Documentation for conversion

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- 30 AWG wire
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- No stripping or slitting required—just wrap
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- Built-in cut off
- Includes 50 ft. wire

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JUST WRAP™ Replacement Wire

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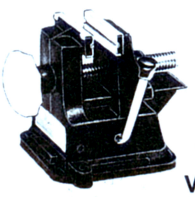
R-JW-Y	Yellow	50 ft. roll	2.98
R-JW-R	Red	50 ft. roll	2.98

JUST WRAP™ Unwrap Tool $3.49

ok Vacuum Vise



Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws, 1½" travel. Can be permanently installed.

VV-1...... $3.49

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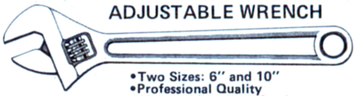

- Two Sizes: 6" and 10"
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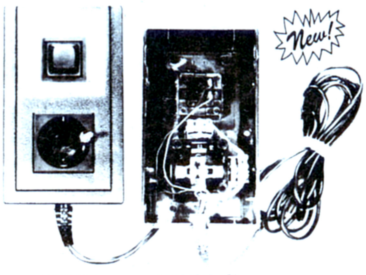
6"– AW-6 . . $4.95 10"– AW-10 . . $6.95

JOYSTICK VIDEO CONTROLLER



FRONT VIEW   INSIDE REAR VIEW

- IDEAL FOR ALL VIDEO GAMES OR REMOTE CONTROL PROJECTS
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- 2 MINIATURE POTENTIOMETERS – 40K OHM EACH
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- RUGGED PLASTIC CASE

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- —interactive debug
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THIS SET INCLUDES:
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- 1 MC3242A MEMORY ADDRESS MULTIPLEXER AND COUNTER
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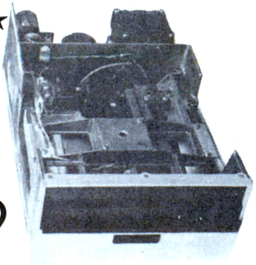

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ONLY
$489

Hazeltine 1000 (unused)	$ 599
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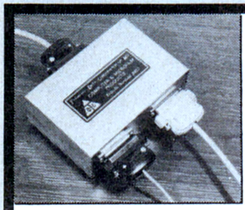

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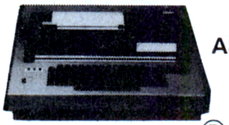
ASCII



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- Two 8" Floppy Disk Drives
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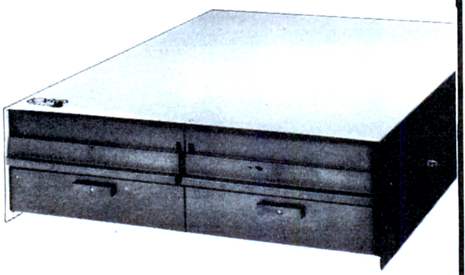

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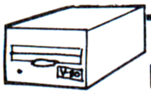

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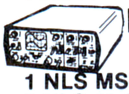
Two Drive Systems comes Complete with Data Cable



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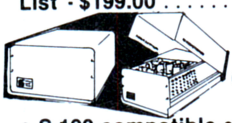

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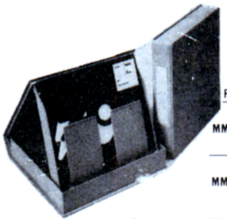

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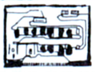

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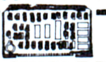

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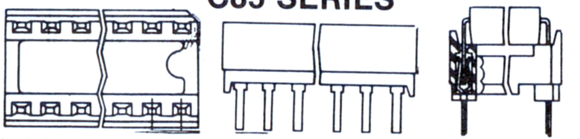

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TIS-16LP	16	N/A	.20	.18	.16	.13	.12
TIS-18LP	18	.30	.25	.22	.18	.15	.13
TIS-20LP	20	.30	.25	.23	.20	.17	.145
TIS-22LP	22	.35	.30	.25	.22	.19	.17
TIS-24LP	24	.40	.35	.30	.24	.20	.18
TIS-28LP	28	.45	.40	.35	.28	.24	.21
TIS-40LP	40	.50	.45	.42	.40	.35	.31

*MINIMUM ORDER $1.00 Per Line item
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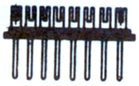

PART NO.	PINS	PRICE 1-9	10-24	25-99	100-249
KNX-08DP	8	.50	.45	.43	.40
KNX-14DP	14	.65	.60	.58	.55
KNX-16DP	16	.70	.65	.62	.58
KNX-24DP	24	1.15	1.05	.90	.95
KNX-40DP	40	1.90	1.70	1.60	1.50

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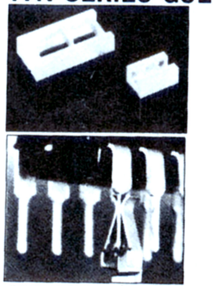

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RNS-14WWG	14	.60	.49	.47	.45	.42
RNS-16WWG	16	.65	.52	.50	.47	.44
RNS-18WWG	18	.85	.75	.70	.65	.60
RNS-20WWG	20	1.00	.90	.80	.75	.70
RNS-22WWG	22	1.25	1.15	1.10	1.05	1.00
RNS-24WWG	24	1.25	1.15	1.10	1.05	1.00
RNS-28WWG	28	1.60	1.50	1.40	1.30	1.20
RNS-40WWG	40	1.85	1.65	1.55	1.45	1.35

*Price based on gold not exceeding $500 per oz.
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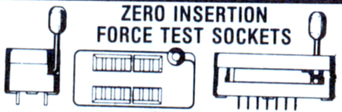

ZIP-16DIP	$5.50
ZIP-24DIP	$7.50
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FEATURES

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- 50 (Wire Wrap) to 75 (solder tail) microinches gold inlay over a nickel diffusion barrier (minimum thickness).
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- Bifurcated contact points.
- Preloaded, cantilever spring design.
- Contacts are user removable.

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- Glass-filled thermoplastic polyester — Meets U.L. Flammability Classification 94V-0. — Resists common cleaning solvents.
- Solder standoff — Facilitates cleaning — Reduces solder wicking
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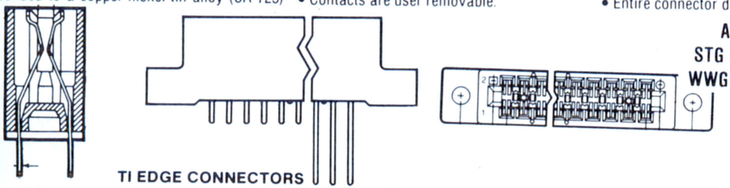
- Generous chamfered card slot.
- Molded contact identification — Alphanumeric (.156" centers) — Numeric (.100" & .125" centers).
- Location ridges (bottom) and raised dots (top) mark every fifth contact position.
- Entire connector design is U.L. Approved.

ABBREVIATIONS:
STG — Solder Tail Gold
WWG — Wire Wrap Gold



TI EDGE CONNECTORS

.1" Contact Centers: STG - Soldertail GOLD; WWG - Wire Wrap GOLD

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TIC-1836-1 STG	2.00	1.80	1.60	1.40
TIC-1836-1 WWG	2.10	1.90	1.65	1.45
TIC-2244-1 STG	2.25	2.00	1.75	1.50
TIC-2244-1 WWG	2.40	2.15	1.90	1.60
TIC-2550-1 STG	2.50	2.25	2.00	1.65
TIC-2550-1 WWG	2.70	2.45	2.15	1.80
TIC-3060-1 STG	2.95	2.60	2.30	1.90
TIC-3060-1 WWG	3.20	2.85	2.55	2.20
TIC-3672-1 STG	3.30	2.95	2.60	2.30
TIC-3672-1 WWG	3.90	3.50	3.10	2.60
TIC-4080-1 STG	3.60	3.25	2.85	2.40
TIC-4080-1 WWG	4.40	4.00	3.60	3.00
TIC-4386-1 STG	3.90	3.50	3.10	2.60
TIC-4386-1 WWG	4.65	4.15	3.70	3.10
TIC-50100-1 STG	4.50	4.05	3.60	3.00
TIC-50100-1 WWG	5.40	4.90	4.30	3.60

.125" Contact Centers: STG - Soldertail GOLD; WWG - Wire Wrap GOLD

PART NO.	PRICE 1-9	10-24	25-99	100-249
TIC-2244-2 STG	2.30	2.10	1.85	1.50
TIC-2244-2 WWG	2.60	2.35	2.10	1.75
TIC-2856-2 STG	2.80	2.55	2.25	1.85
TIC-2856-2 WWG	3.20	2.90	2.55	2.15
TIC-3060-2 STG	2.90	2.60	2.30	1.95
TIC-3060-2 WWG	3.40	3.05	2.70	2.25
TIC-3162-2 STG	3.05	2.75	2.45	2.05
TIC-3162-2 WWG	3.50	3.15	2.80	2.35
TIC-3672-2 STG	3.45	3.10	2.75	2.30
TIC-3672-2 WWG	4.00	3.60	3.20	2.68
TIC-4080-2 STG	3.80	3.45	3.05	2.55
TIC-4080-2 WWG	4.45	4.00	3.55	2.95
TIC-4488-2 STG	4.20	3.80	3.35	2.80
TIC-4488-2 WWG	4.85	4.35	3.90	3.20
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TI-S100WWG S-100 WIRE WRAP	4.00	3.75	3.50	3.25

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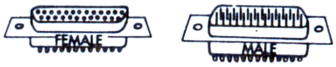

P = Plug, Male Type - S = Socket, Female Type - C = Cover, Hood

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CND-DE9S	9 Pin Female	2.35	2.10	2.00
CND-DE9C	9 Pin Cover	1.50	1.35	1.20
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CND-DA15S	15 Pin Female	3.35	3.20	3.00
CND-DA15C	15 Pin Cover	1.60	1.45	1.30
CND-DB25P	25 Pin Male	2.90	2.70	2.50
CND-DB25S	25 Pin Female	3.75	3.65	3.35
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DB-P258C	2 pc Grey Hood	1.45	1.25	1.00
DB1226-1A	2 pc Black Hood	1.90	1.65	1.45
CND-DC37P	37 Pin Male	4.40	4.20	3.90
CND-DC37S	37 Pin Female	6.20	5.95	5.70
CND-DC37C	37 Pin Cover	2.25	2.00	1.75
CND-DD50P	50 Pin Male	5.75	5.45	5.00
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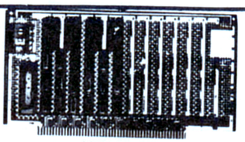

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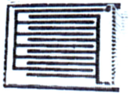

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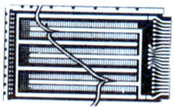

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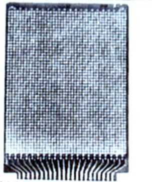

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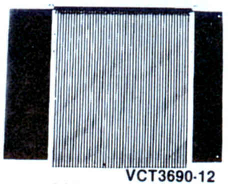

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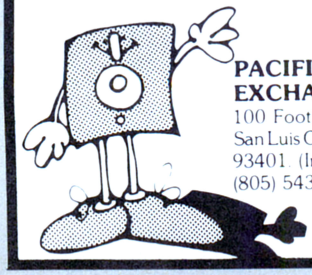

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(2) for IBM 3740 series and compatible drives
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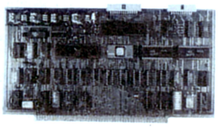

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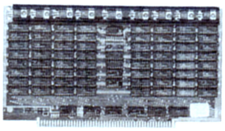

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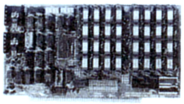

Basic dynamic board tested to run at 4MHZ with our Z-80 board. 4116 chips at 200 nanosecond speed insures most reliable data storage. Double density and DMA compatible.

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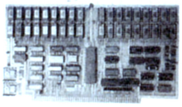

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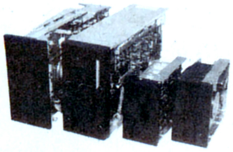
FLOPPYS



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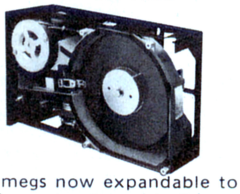
WINCHESTER/SHUGART SA 1000



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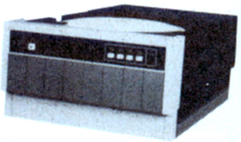
(Hunter Shown)



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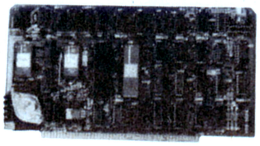

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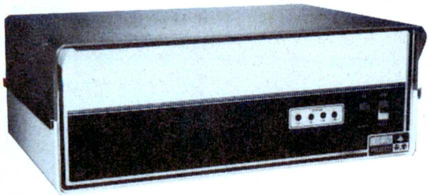
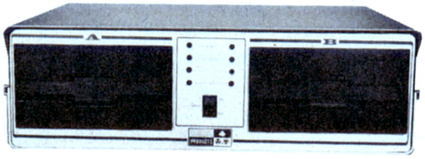
DP S-100 Main Frame



- 12 slot S-100 Motherboard (6 populated)
- +8V @ 20A ±16V @ 6A. (Nylon card guides).
- Mates with disk system shown in center column.
- 3 user convenience outlets at rear.
- Status indicators for I/O wait, memory error, voltage levels.
- Multi-user capable with circuit board selection at top.

Kit (less fans) $295.00 A & T $450.00

Disk Drive Storage



- Cabinet comes with multiple power.
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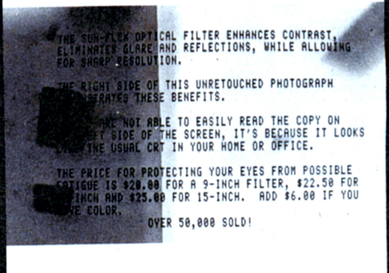

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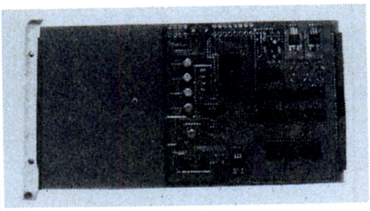

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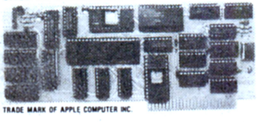

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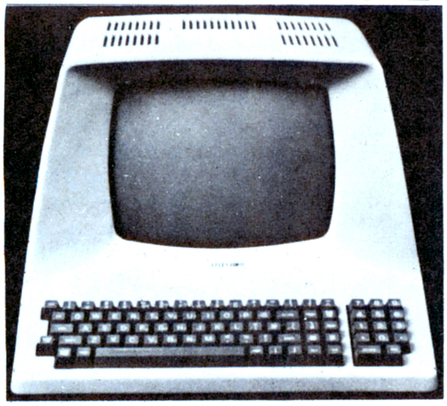

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MICROMATION Doubler, DD, A&T	$399
TARBELL Floppy Disk Interface, Kit	$199
double density, Kit, List $325	295
double density, A&T, List $425	380

SHIPPING & INSURANCE — Add $2 for boards, $5 for Selectric converter, $7.50 for Floppy Disk Systems, $15 for Horizons. Shipped freight collect: Cromemco Systems, Centronics, DEC, NEC, and T.I. printers. Contact us for shipping information on other terminals and printers.

All prices subject to change and all offers subject to withdrawal without notice. Prices in this ad are for prepaid orders. Slightly higher prices prevail for other-than-prepaid orders, i.e., C.O.D., credit card, etc.

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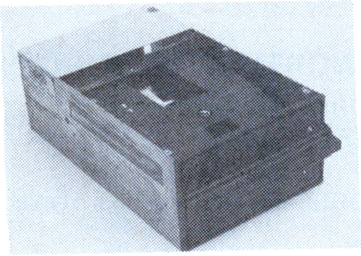
Circle 305 on inquiry card.

FLOPPY DISK DRIVES SYSTEMS

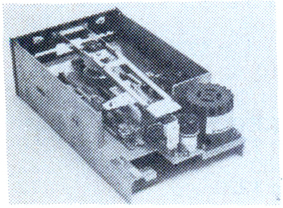
Qume Datatrak

Double sided floppy with NO **HEADACHES.** Although many think this an impossibility, seeing is believing, and this drive is really something! Shugart compatible, fully optioned, reliable, and rapidly becoming the standard in double-sided diskdom.
$599. 2/$549.



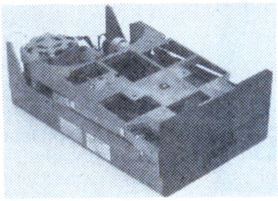
Siemens FDD100-8D

All Siemens options included in this drive, which can be configured hard/soft sector, is Shugart compatible, and not prone to some overheating problems (that other drives are). A highly reliable machine, with write protect, file busy indicator, and more. **$499.**



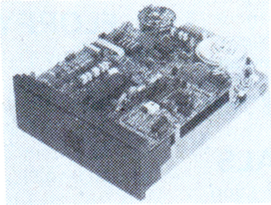
Cal Disk 142M 8″

Built like the proverbial tank. Single/double density, write protect, much more. With Electrolabs' special cabling, it magically becomes Shugart compatible.
Please ask about Cal Dis, enclosure and power supply package bargian. **$389. 2/$379.**



The following 5¼″ mini-floppies share most features with their 8″ cousins, so without further ado. . .

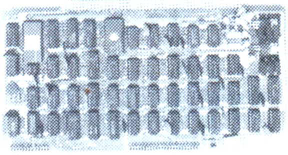
Siemens FDD 100-5D	$279
Cal Disk Mini	$279
Qume Datatrak 5 (double sided)	$399
BASF Mini mini	$279
SA 400	$299

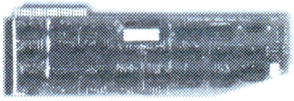


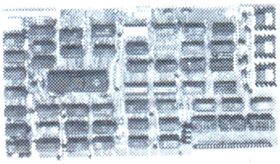
All the above mini-floppies are fully SA400 compatible.

Manuals for all drives are $10, refundable against future purchase of drives. Also, all 8″ drives can be ordered with 220 v/50 hz for worldwide use.

Moving on to the realm of floppy disk controllers . . . although we still feel that single density is more reliable, there are many excellent double density disk controllers available, so choose your weapons carefully.





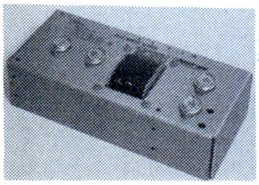


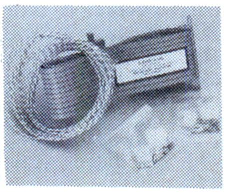
Tarbell floppy disk controller, A & T	$325
Tarbell floppy disk controller, A & T	$225
Tarbell double density, DMA A & T	$425
Tarbell double density, DMA, kit	$325
Delta Products double density disk controller Operate at 2 or 4MHZ, with 8 or 5″ drives	$399
Micromation doubler w/programmable UART RS-232 port	$495
Sorrento Valley single density for Apple	$399

Again, purchase price of manuals ($5) is applicable towards future purchase price.

Subtract 15% OFF any Controller with Purchase of 2 Drives.

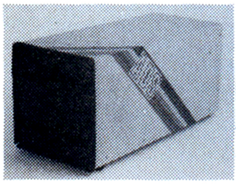
Disk Accessories

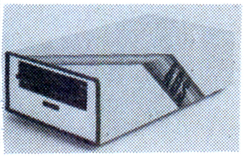




Cable kits for 8″ drives with 10′50 cond. flat cable, power cable, & all connectors. Assembled if desired. ONe drive 27.50, two 33.95, three 38.95 for mini floppies (34 cond): one 24.95, two, 29.95

CP-206 Power-one power supply. Powers two drives more than adequately, top quality. 2.8A/24V, 2.5A/5V, .5A/-5V. **$99.**



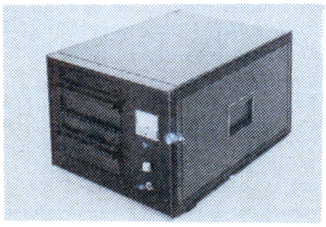


Double disk drive enclosure.
Enclosure alone **$139.**
Including power supply & fan **$199.**

Single disk drive enclosure. Fits all 8″ disk drives, please specify make & model No. of drive to assure proper mounting hole positions. Nonmar paint available in blue, beige, silver, & off-whilte.
Enclosure alone **$60**
Including power supply & fan **$109.**

Electrolabs
POB 6721, Stanford, CA 94305
415-321-5601 800-227-8266
Telex: 345567 (Electrolab Pla)
Visa MC Am. Exp.

ENCLOSURES, SLEEVES



Rackmount Mainframe MT-200. This gorgeous beast is so appealing that it can easily function also as stand-alone mainframe. Very modern styling with fully actively terminated S-100 bus.
Enclosure alone **$399.**
With power supply & fan **$499.**
With 15 slot S-100 bus **$699.**
With two 8″ single-sided disk drives **$1,699.**
With two 8″ double sided disk drives in place of single-sided variety **$2,299.**

Media

8″. . **$39.95**/10 single-sided/single density
8″... **$55.00** single sided/double density
8″. . **$55.00** double sided/single density
8″. . **$60.00** double sided
8″. . specify hard or soft
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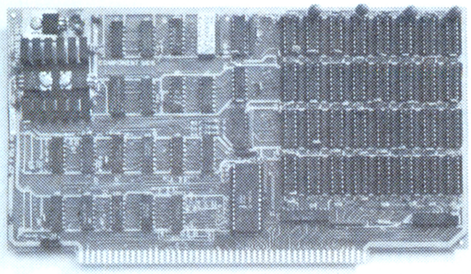
Verbatism, Memorex, Scotch,or equivalent name brand
Diskette head cleaning kid for 5¼″ or 8″ – **$28.75** includes everything for 1 drive for 1 year
Alignment Diskette **$39**
For Floppy Drives



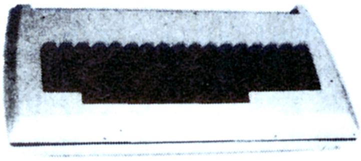
EXTRA SPECIAL !!

Imsai 65K dynamic RAM III

We made a special purchase of this now unavailable board, which were always noted for their fine performance & quality. We have a limited quanity on hand, get your orders in rapidly. These come assembled and tested, with burned-in 200 Ns RAM. Kit 299

A & T **$399.**

Keyboard Special

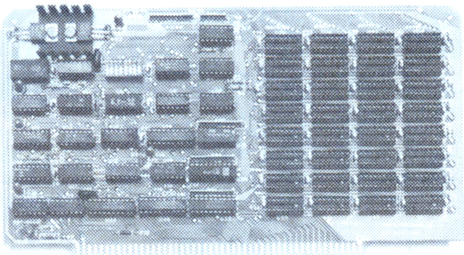


CHERRY "PRO" Keyboard **$119.00**
Streamlined Custom Enclosure **$34.95**
BOTH ONLY **$134.95!!!**

SD Systems Expandoram II Dynamic RAM

Operates at 4 Mhz, expandable memory from 16K to 256 K, allows up to 8 boards on the same bus, Z-80 based, and invisble refresh, among other things.

16K kit	$295.
16K A & T	$349.
32 K kit	$369.
32 K A & T	$419.
48K Kit	$440.
48K A & T	$490.
64K kit	$510.
64K A & T	$560.



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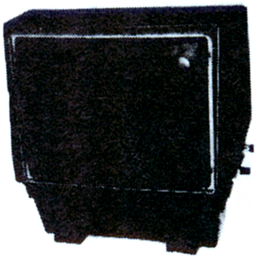
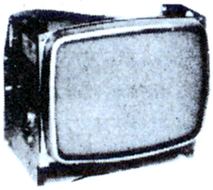
Used 12" Sylvania monitors. Composite Video, 15 MHz, 120VAC. Rebuilt with NEW P39 anti-glare tube $89.00 New P4, $89.00, used P4 $69.00
U-fix model, 10/$300.00





"OEM STYLE" as above, will fit any case, (Both versions serviced by qualified tech). Identical to above but subtract $12.00

Televideo 912c $760.

Upper/lower case
Adjustable baud rate — 80 X 24
Editing capabilities — Printer port
Second page memory option

This is a VERY limited extravaganza, so please act quickly

New!

Televideo 920c $860.

Same specs as above, save for special function keys, ideal for text editing and word processing

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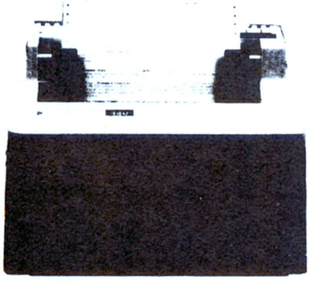
(415) 321-5601 (800) 227-8266
Telex: 345567 (Electrolab Pla)



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- 8 Software Selectable Character Sizes
- Parallel & Serial Interface
- 98 ASCII Character set, upper & Lower case
- Forms length control
- Tractor Feed **$899.**

Graphics option with 2K CRT screen buffer add $199.00

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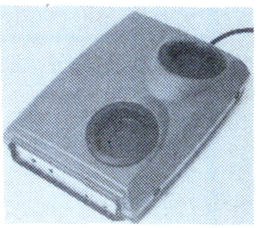
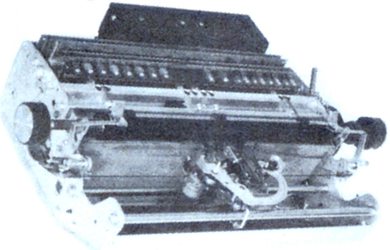
- Acoustically coupled modem assembly set
- Asynchrous 0-300 Baud
- Switchable originate or answer modes
- Operates full or half duplex mode
- 15 minute assembly **$129.**
- Novation Cat **$179.**
- Digicomm Coupler **$189.**



Daisy Wheel Printers



Qume Sprint 3\45

PRINTER (factory warr.)	$1499.
POWER SUPPLY (Borschert) (Shown mounted on rear of printer)	349.
COMBINATION SPECIAL	1699.
Cases available	200.
S-100 interface card	149.
SPRINT 5/45 RO, RS-232 Complete, assembled, in case, plug-in & print, hence, no muss & no fuss	$2699.

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(while supply lasts)

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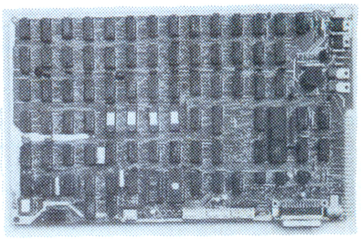
UNPRECEDENTED!!!
* 16K Dynamic RAM Set of 8 For: TRS-80, Apple, Exidy, Heath, etc.
* Includes all parts & instructions
* 200 NS **$59.**

Please call for dealer or quantity pricing. Minimum order $20.00
We do custom prom programming.



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Circle 307 on inquiry card.

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4021 — 1.10
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4023 — .22
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4035 — .97
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4049 — .75
4050 — .45
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4052 — 1.10
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DATEL'S DAC-08BC — 8 bit DAC — $9.95

8" DISKETTES — HARD SECTOR
$1.75, 10/$16.00

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4.000 MHz
3.57 MHz
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20.000 MHz

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4" x 6" DOUBLE SIDED EPOXY BOARD 1/16" thick $.60 ea	5/$2.60
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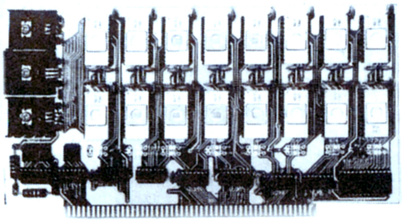

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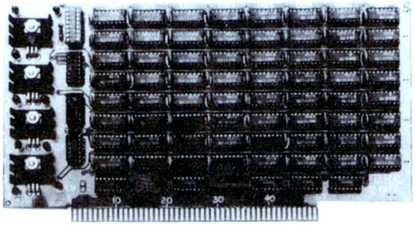

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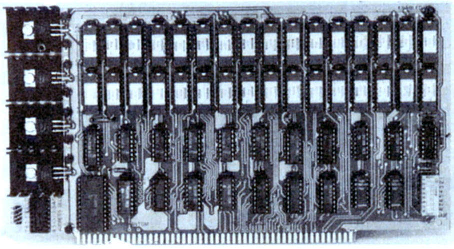

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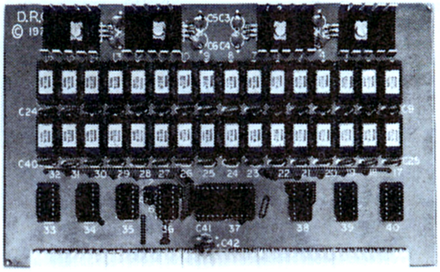

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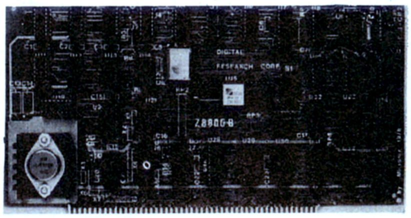

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PET C2N External Cassette Deck	$ 95	**$ 12**
Used 8K PETs (limited quantities)	$ 495	

★ **EDUCATIONAL DISCOUNTS** ★
Buy 2 PET Computers, get 1 FREE

*Free Merchandise with Purchase of PET-CBM Item.

KIM-1 $159 (add $30 for power supply) SYM-1	$209
BAS-1 Microsoft ROM Basic for SYM	$ 85
Memory Plus (KIM, SYM, AIM)	$195
SYM Assembler in ROM	$ 85
KIM 16K Static RAM	$284
Seawell Motherboard – 4K RAM Space	$139
KTM-2/80 Synertek Video Board	$349
S-100 16K Static RAM Kit **SALE**	$198
TIS PET Workbooks – set of 6	$ 21.50
Dust Cover for PET	$ 7.45

All Book and Software Prices are Discounted

PET Personal Computer Guide (Osborne)	$ 12.75
PET and the IEEE-488 Bus (Osborne)	$ 12.75
6502 Software Cookbook (Scelbi)	$ 9.45

Cassettes (all tapes guaranteed) AGFA PE611 Premium quality, high out put lownoise in 5 screw housing with labels:

C-10	10/5.65	50/25.00	100/48.00
C-30	10/6.90	50/30.00	100/57.00

2716 EPROM (5 volt)	$29.00	5@ 27.00	10@ 25.00
4116 RAM 16K x 1		$7.50	8 @ 7.10
2114 L 450	$5.35	20 @ 4.95	80 @ 4.45
2114 L 300	$6.10	20 @ 5.65	80 @ 5.05
6502	$8.35	10 @ 7.85	40 @ 7.35
6522	$7.15	10 @ 6.95	40 @ 6.45
6520	$5.15	10 @ 4.90	40 @ 4.45
6532	$7.90	10 @ 7.40	40 @ 6.85
6502A			$9.50
6504			$7.95
21L02			$ .90
6550 RAM (PET 8K)			$12.70
S-100 Wire Wrap		$2.85	10 @ 2.65
S-100 Solder Tail		$2.35	10 @ 2.15

ATARI – INTRODUCTORY SPECIAL

ATARI 400, Atari 800 and all Atari Modules 20% OFF.

Programmers Toolkit – PET ROM Utilities	$ 44.90
Sargon II (TRS-80 or Apple) NEW!	$ 24.90
Microchess for PET (Peter Jennings)	$ 17.90
Visible Music Monitor (4 Voice) for PET	$ 29.90
KL-4M 4 Voice Music Board (PET)	$ 34.90
CmC Word Processor (8K $25) (16K $34)	
Adventures by Scott Adams	15% Off

SALE

(write for quantity prices)

Scotch 8" Disks	10/$31.00
Scotch 5¼" Disks	10/$31.50
Verbatim 5¼" Disks	10/$26.50
Diskette Storage Pages	10/$ 3.95
Disk Library Cases 8" - $2.95	5" - $2.15
BASF 5¼" Disks	10/$28.00
BASF 8" Disks	10/$29.00

MINIMAX by COMPU/THINK

MINIMAX I (.8 Megabyte Disks)	$3395
MINIMAX II (2.4 Megabyte Disks)	$4495

SPECIAL — MINIMAX prices include Compu/Think PAGEMATE Database and Report Writer at no charge.

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Montgomeryville, PA 18936

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699-5826

A B Computers

WRITE FOR COMPLETE CATALOG
Add $1.00 per order for shipping.
We pay balance of UPS surface charges on all prepaid orders.

DAL - COMP
MAIL ORDER DIV.

MODEL 550 "BANTUM" CRT

Interactive CRT terminal with high resolution 12" diagonal 24 × 80 display and a 7 × 10 character matrix. All 128 ASCII characters, highlighted numeric pad, RS-232C interface with eleven switchable baud rates (110 to 9600). Inverse video and transparent modes, switchable parity, full or half duplex and stop bits, absolute and relative cursor control from host computer. 115V, 60Hz.

$799.00

DYNAMIC RAMS

4116-250ns	8 for $ 59.95

MICROPROCESSORS

Z80A	$ 13.95
6502	11.95
8035	19.95
8080A	4.95
TMS 9900	29.95

8080 SUPPORT

8212	$ 2.50
8214	4.50
8216	2.50
8224	3.25
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8238	6.25
8243	7.95
8251	6.95
8253	19.50
8255	5.95
8257	17.95

USRT

S 2350	$ 7.95

UARTS

TR 1602 B	$ 3.95
TR 1863	5.95

DISC CONTROLLER

1771	$ 26.95
1791	37.95

PROMS

1702	$ 4.95
2708	7.95
2716—5 Volt	21.95
2758	27.95
2732	85.00

DIP SWITCHES

3 Pos.	$1.00	6 Pos.	$1.10
4 Pos.	1.00	7 Pos.	1.15
5 Pos.	1.00	8 Pos.	1.20

ZIP DIP II SOCKETS

16 Pin	$ 5.50
24 Pin	7.50
40 Pin	10.25

MOTHER BOARDS

6 Slot Bare Board	$ 22.45
6 Slot Kit	47.45
12 Slot Bare Board	37.45
12 Slot Kit	87.45
18 Slot Bare Board	57.45
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RS-232 CONNECTORS

DB25P - Male Plug	$ 2.95
DB25S - Female Socket	3.60
DB25C - Cover	1.50

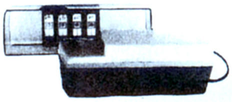
100% 90 DAY MONEY BACK GUARANTEE ON ALL ITEMS SOLD
SEND $2.00 for 1980 CATALOG

THE STAR MODEM From Livermore

$179.00

0 to 300 baud data rate. Compatible with Bell 103 and 113; CCITT. Answer/Originate. Full/Half Duplex. Special self test features.

EPROM ERASER



Compact, durable, quality UV Lamp for erasing EPROM's. Features a special safety lock to prevent accidental exposure. Erases up to four devices (2708, 2716, 2732, 1702A, 5203Q, 5304Q, etc.) simultaneously.

UV-4/20 **$68.95**

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MAIL ORDER DIV.

TERMS OF SALE: Cash, checks, money orders, VISA, Master Charge. Minimum order $10.00. Texas residents add 5% sales tax. Minimum shipping and handling charge $2.50. COD orders add $1.15 COD fee. U.S. funds only. D&B rated firms call for open account.

DAL-COMP M/O DIV. 2560 ELECTRONIC LANE, SUITE 108, DALLAS, TEX. 75220 • (214) 350-6895

Circle 321 on inquiry card.

page

DEAL #1

Hobby Wire Wrap Starter Package

BW2630	WW Tool	$19.95
BT30	#30 Bit	3.95
BC1	Batteries & Charger	14.95
*Kit #1	Wire Kit	9.95
	Regular Price	$48.80

$39⁹⁵

*Kit #1 Contains 900 pcs. of precut wire in asst. sizes.

Choose from Red, Blue, White, Black, Green, Orange, Violet, Yellow, or assortment.

DEAL #2

Industrial Wire Wrap Starter Package

BW928BF	WW Tool	$52.95
BT30I	#30 Bit & Sleeve ..	29.50
BC1	Batteries & Charger	14.95
*Kit #3	Wire Kit	32.95
	Regular Price ...	$130.35

$119⁹⁵

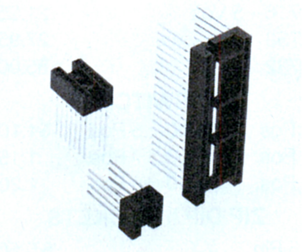
*Kit #2 Contains 4000 pcs. of precut wire in asst. sizes.

Choose from Red, Blue, White, Black, Green, Orange, Violet, Yellow or assortment.

★ ★ BIG DEAL ★ ★

RN IC Sockets by the Tube

RN HIGH RELIABILITY eliminates trouble. "Sidewipe" contacts make 100% greater surface contact with the wide, flat sides of your IC leads for positive electrical connection.



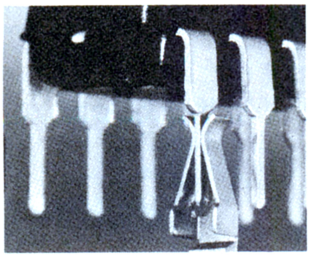
WIRE WRAP SOCKETS

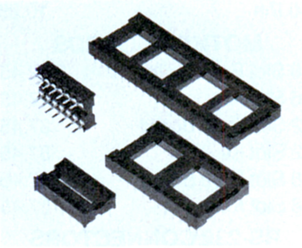
3-level Gold Closed Entry Design

*Sockets sold at these prices by the tube only.

Size	Quantity/Tube	Price ea.*	Price/Tube
08 pin	52	.39	**$20.28**
14	30	.46	**$13.80**
16	26	.50	**$13.00**
18	23	.68	**$15.64**
20	21	.85	**$17.85**
22	18	.42	**$16.56**
24	17	.94	**$15.95**
28	15	1.23	**$18.45**
40	10	1.60	**$16.00**

Above prices include gold up to $800/oz.





SOLDER TAIL

Low Profile Tin Closed Entry Design

*Sockets sold at these prices by the tube only.

1¢/pin (over 5 tubes)

3/4¢/pin (over 100 tubes)

See tube quantities above.

ORDERING INFORMATION

- Orders under $25 include $2 handling
- All prepaid orders shipped UPS Ppd.
- Visa, MC & COD's charged shipping
- All prices good through cover date
- Most orders shipped next day.

Limited to products Page Ditigal stocks. All discounts are off of list price. Call or write for list prices.

10% off on all OK hobby products!
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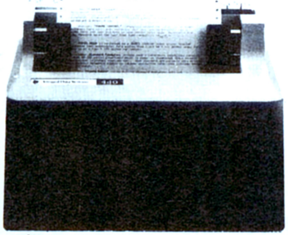
FREE

With Purchase of The INTEGRAL DATA 440

Paper Tiger



Your Choice, $200 Value

1) **Graphics Option Package**
2) **Interface for APPLE II**
3) **TRS-80 Printer Interface**

California Digital has resently researched the complete low cost printer market. It is our opinion that the IDS 440 Paper Tiger is, without doubt, the most versatile and offers the best value of any printer costing under $1,000.

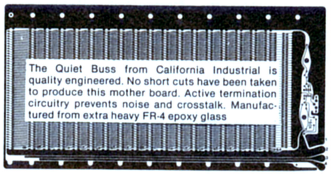
This quality dot matrix printer incorporates such features as software selectable character size to allow print densities upto 132 characters per line. Full forms handling capabilities and tractor feed mechansim adjustable to 9.5". The Paper Tiger is engineered to accept either parallel or RS232 serial ASCII. 110/220V.50/60Hz.

***** $995.00 plus shipping *****

S-100 Mother Board

Quiet Buss

$29.95
8803-18
18 slot
IMSAI



The Quiet Buss from California Industrial is quality engineered. No short cuts have been taken to produce this mother board. Active termination circuitry prevents noise and crosstalk. Manufactured from extra heavy FR-4 epoxy glass

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TELETYPE® MODEL 43

4320 KEYBOARD

TTL	AAA	$1050
RS232	AAK	1150
Friction	AAE	1100
103 Modem	AAB	1575

plus shipping

$149

MOTOROLA

New factory surplus. M3000/3211 Motorola CRT monitors.

20 MHz bandwidth Electronics terminate into single ten pin (.156") edge connector. Requires DC power supply

---

FREE

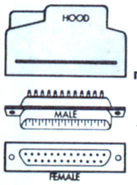
PLASTIC LIBRARY CASE with purchase of each box of .... Memorex mini-diskettes. $5 value.

$24.95

BOX of 10

DISKETTES

CONNECTORS

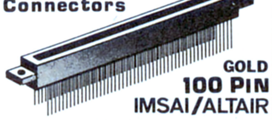


RS-232

DB25P male plug & hood $3.95

DB25S female $3.95

Edge Connectors



GOLD 100 PIN IMSAI/ALTAIR

Imsai solder .125x.250	$2.95	3/$ 7.50
Imsai w/w .125 centers	$4.95	3/$13.00
Altair soldertail .140 row	$5.95	3/$15.00
SPECIALS		
22/44 Kim eyelet .156"	$1.95	3/$5.00
25/50 solder tab .156"	$1.09	3/$2.00
36/72 wide post w/w .156	$1.95	3/$5.00

COMPUTERS

Apple II standard 16K	$988
Apple Plus 16K	988
Atari 400	450
Atari 800	850
Texas Instruments 99/4	895.
Northstar Quad 32k Horizon	2995
Vector MZ	
Compucolor II Model 3	1395
Rockwell Aim 65 (1K)	375

CRT TERMINALS

ADDS Regent 25 (ten key pad)	850
ADDS Regent 40	1195
ADDS Regent 60	1495
Hazeltine 1420	850
Hazeltine 1500	995

MONITORS

Sanyo 9" black & white monitor	179
Leedex Video 100 12"	125
Leedex Video 100-80 12"	179

PRINTERS

IDS440G Tiger with Graphics	$995
Printronix P-300 (300 LPM)	4900
Printronix P-600	
Teletype Model 43 (RS232)	1150
Teletype Model 40(132 col.)	
NEC Spinwriter 5510 R/O	2595
Texas Instruments 810	1650
Centronics 730 friction	695
Centronics 779-2 tractor	995
Centronics 704	1950
Anadex DP8000	895
Anadex DP9500	
Anadex DP9501	
Diablo 1640 R/O plastic wheel	2750
Diablo 1640 KSR plastic wheel	3150

MODEMS

Universal Data Systems LP300 Direct coupled * FCC Approved powered from phone line.	169
Novation Cat Acoustic	169

DISK DRIVES

Shugart SA800R 8" floppy	$449
Shugart SA801R 8" hard sec.	479
Lobo / Two Shugart 801's with power supply and enclosure	1195
One Shugart 801 with power supply and enclosure	795
Lobo hard drive for Apple 10 meg/byte 7710a	3995
Lobo hard drive for TRS80	3995
Lobo 400-t 5 1/4" for TRS80	388
Vista V-80 for TRS80 (40trk)	388
Corvus Systems hard drive	

APPLE COMPATIBLE PRODUCTS

Apple disk drive with controller	560
Apple drive without controller	495
Apple Parallel Interface	179
Ten Key Data Pad for Apple	119
Mountain Hardware Supertalk	279
Mountain / Intro X-10 for BSR	239
***** Memorex Special **********	
8" soft sector diskettes (10)	27
8" double density for TRS80	30

S-100 PRODUCTS

Godbout Rack Enclosure	$289
Godbout Desk Top Enclosure	329
Electronic Controls ECT 100F	250
Cal. Digital 18 slot motherbd.	30

S-100 BOARDS

Think/Toys Switchboard I/O	219
Godbout Econoram Products	
Mullin TB-2 Extend. & Logic	49
Artec WW100 WireWrap Proto	25
SD 64K Expandoram Memory	

16 BIT S-100 BOARDS

Cal. Digital CAL-86	650
Tecmar 8086	650
Seattle Computers 8086	850
Godbout 8088/8085	
Ithaca Intersystems Z-8000	

MISCELLANEOUS

Cherry Pro ASCII Keybd.	129
Maxiswitch HEX Keyboard	49
UV Eraser 11-E	65
Super Mod II RF Modulator	30

Authorized Distributor

Scotch® Data Products

		10 Pak	50+
740-0	IBM soft format.	$39.00	$3.50
740/2	Double side soft	65.00	6.00
741-0	Double density	53.00	4.90
743-0	Double/Double	70.00	6.60
740-32	8" Hard sector	39.00	3.50
744-(0)(10)(16)	5 1/4" mini	39.00	3.50
Library case for any above;		Add $3.00	
834 A	Data Cassette	5.50	
DC100	Mini Cartridge	16.00	
DC300	Data Cartridge	20.00	
920( )	Disk Cartridge	89.00	

Shugart Associates

SA800-R Floppy Disk Drive

The most cost effective way to store data processing information, when random recall is a prime factor. The SA800 is fully compatible with the IBM 3740 format. Write protect circuitry, low maintenance & Shugart quality.

$449.50

XEROX 800 WORD PROCESSING KEYBOARD ASCII ENCODED

This 77 key word processing keyboard was manufactured by Microswitch for use in the Xerox 800 word processing system.

The keyboard outputs a seven bit ASCII code along with an eighth bit that allows most keys to shift and double function as special characters. Extra large "Tab & Return" keys are designed into the layout of the keyboard to emulate the IBM Selectric. 17 illuminated keys serve for special word processing codes. The keyboard is equipped with two thumbwheel switches for defining line width.

Original Xerox acquisition over $400.00
California Digital USED price only $49.00
Excellent cond. Documentation included.

MEMORY

TRS-80 APPLE II $59

16k memory (8) 4116's

Installation is simple. Anyone who has ever changed a spark plug should be able to up-grade his microcomputer.

How can California Digital offer these memory up-grade sets at 25% below our competition? Simple, we buy in volume, wholesale to dealers and sell the balance directly to owners of personal microsystems. These 16K dynamic memory circuits are factory prime and unconditionally guaranteed for one full year. NOW, before you change your mind, pick up the telephone and order your up-grade memory from California Digital. Add $3 for TRS80 jumpers.

STATIC	1-31	32-99	100-5C	-999	1K+
21L02 450nS.	1.19	.99	.95	.90	.85
21L02 250nS.	1.49	1.39	1.25	*	*
2114 1Kx4 450	5.95	5.50	5.25	4.75	4.50
2114 1Kx4 300	8.95	8.50	8.00	*	*
4044 4Kx1 450	5.95	5.50	5.25	*	*
4044 4Kx1 250	9.95	9.50	9.00	*	*
4045 1Kx4 450	8.95	8.50	8.00	*	*
4045 1Kx4 250	9.95	9.50	9.00	*	*
5257 low pow.	5.95	5.50	5.00	4.80	4.60

SPECIAL CIRCUITS

Z80A 4 MHz.	24.95	AY5-1013A UART	4.95
8080A CPU	9.95	Floppy Disc Controllers	
8085	22.50	WD1771 single D.	39.95
8086 Intel 16 bits	85.00	WD1781 Double D	65.00
TMS9900 16 bits	49.95	WD1791 D/D 3740	*

EPROMS		1-15	16-63	64+
1702A	2K	4.95	4.50	4.00
2708	8K	9.95	9.50	9.00
2716 5v	16K	29.95	27.50	*
2716 TI		24.88	20.00	*
2532		85.00	*	*

SYSTEM X-10

It's not offen that California Digital ventures into the distribution of consumer products, but we have resently come accross a product that appears so unique that we just had to add it to our product line. This is the System X-10 manufactured by the BSR turntable company. This space age system will remotely control any light or appliance in your home or office. Command signals are transmitted from the command console over your existing wiring. From your bed or easy chair you can control up to 16 different electrical devices inside and outside your home. Use the System X-10 to control your stereo, television or any light fixture on the premises.

The modular system is available in the following components:

Ultrasonic Master Control Console	$34.95
Battery Operated Ultrasonic Controller	19.95
Appliance Module, Lamp Module or Wall Switch	13.95

$89 USED

ACOUSTIC MODEM

The Omnitec model 701 Modem connects the RS-232 serial port of your computer or peripheral device acoustically to your telephone line.

Place the telephone handset into cradle of the modem, instantly your computer system has access to the world of digital information.

Half and full duplex ability.

Regent® 25

Through years of research the ADDS Corporation has evolved a low maintenance, extremely durable CRT terminal capable of withstanding an abusive 24 hour duty cycle. The Regent 25 features Intel 8085 microprocessor controlled circuitry along with the Cherry Switch long-life capacitance keyboard.

18 key cursor and numeric pad doubles to allow for user definable special functions. True descending lower case characters along with a fully addressable cursor makes the Regent 25 the ideal word processing terminal.

High-resolution screen is capable of displaying 96 upper and lower case ASCII characters and 32 control codes. This terminal is switch selectable to display six European languages.

At $850 (plus shipping) the Regent 25 offers the best value in todays CRT terminal market. Additional data upon request.

MINIATURE SWITCHES

your choice

	10	50	100	1k
$.98	$.88	.81	.73	.66

SPDT Miniature Toggles

7101 C&K	ON-NONE-ON
7107 jbt	ON-OFF(mnt.ON)
7108 CK	ON-(moment ON)
7103 CK	ON OFF ON
Rotary	3P-4-Pos.
Rotary	3P-6-Pos.
Push B (N.O.)	$.39ea. 4/$1

DIP Switch

	10	25	100	1K
$1.29 ea.	$1.19	1.09	.97	.83

specify 4, 7 or 8 pos.

1
2
3
4
5
6
7
8
OPEN

SPST

$139.50

PORTABLE DATA ENTRY SYSTEM

These used data terminals were originally designed for chain store inventory control and order entry systems. The operator enters the inventory control number, merchandise on hand and the unit price. After all pertinent data has been entered into the recorder, the main warehouse is telephoned, the handset is placed in the acoustic coupler and all the recorded information is transmitted back to the master computer. With a little imagination and one of these portable entry systems, you should be able to exchange programs and computer information with associates across the country. All units were removed from service in working condition. Original cost $2,500. Each system comes complete with:

- Portable Cassette Drive Unit
- Removable Entry Keyboard with LED Display
- Five Gould "D" NiCads
- Acoustical Coupler
- Battery Charger
- DB25 Cable
- Shoulder starp
- Full Documentation

DISCOUNT

Wire Wrap Center

IC SOCKETS

pin	wire wrap ea.	25	50	low profile ea.	25	50
8	—	—	—	17¢	16	15
14	37¢	36	35	18	17	16
16	38	37	36	19	18	17
24	99	93	85	36	35	34
40	169	155	139	63	60	58

KYNAR WIRE WRAP

50ft. $.98

500	1,000	11,000
$9.	$15.	$105.

Battery **wire wrapping** tool

~~$34.95~~

$29.95
BW630

OK HOBBY WRAP-30
wire wrap & strip tool

$5.45

---

(213)679-9001

All merchandise sold by California Digital is premium grade. Sorry, no COD's. Orders are shipped the same day received. California residents add 6%. Foreign orders add 10%. Orders over $25, when accompanied by payment, are shipped at our expense. Otherwise, please add $2.

VISA

master charge

ADVANCED COMPUTER PRODUCTS

7400

SN7400N	.19	SN74123N	.59
SN7401N	.22	SN74125N	.39
SN7402N	.22	SN74126N	.44
SN7403N	.22	SN74128N	.59
SN7404N	.22	SN74132N	.69
SN7405N	.23	SN74136N	.95
SN7406N	.23	SN74139N	.95
SN7407N	.23	SN74141N	.69
SN7408N	.26	SN74142N	2.95
SN7409N	.23	SN74143N	2.95
SN7410N	.22	SN74144N	2.95
SN7411N	.29	SN74145N	.62
SN7412N	.29	SN74147N	1.95
SN7413N	.39	SN74148N	1.20
SN7414N	.59	SN74150N	.99
SN7416N	.29	SN74151N	.67
SN7417N	.29	SN74152N	.67
SN7420N	.22	SN74153N	.67
SN7421N	.35	SN74154N	1.19
SN7422N	.29	SN74155N	.82
SN7423N	.29	SN74156N	.89
SN7425N	.29	SN74157N	.69
SN7426N	.29	SN74158N	1.65
SN7427N	.29	SN74160N	.95
SN7429N	.45	SN74161N	.95
SN7430N	.23	SN74162N	.89
SN7432N	.29	SN74163N	.87
SN7437N	.29	SN74164N	.97
SN7438N	.29	SN74165N	.97
SN7439N	.29	SN74166N	1.20
SN7440N	.24	SN74167N	1.95
SN7441N	.79	SN74170N	1.69
SN7442N	.57	SN74172N	5.95
SN7443N	.79	SN74173N	.79
SN7444N	.79	SN74174N	.89
SN7445N	.79	SN74175N	.89
SN7446N	.79	SN74176N	.85
SN7447N	.59	SN74177N	.85
SN7448N	.79	SN74179N	1.80
SN7450N	.23	SN74180N	.75
SN7451N	.23	SN74181N	1.75
SN7453N	.23	SN74182N	.75
SN7454N	.23	SN74184N	1.95
SN7459N	.29	SN74185N	1.95
SN7460N	.23	SN74186N	9.95
SN7470N	.39	SN74188N	3.90
SN7472N	.34	SN74190N	1.15
SN7473N	.38	SN74191N	1.15
SN7474N	.36	SN74192N	.85
SN7475N	.38	SN74193N	.85
SN7476N	.36	SN74194N	.85
SN7479N	4.60	SN74195N	.85
SN7480N	.59	SN74196N	.85
SN7481N	1.10	SN74197N	.85
SN7482N	1.10	SN74198N	1.39
SN7483N	.55	SN74199N	1.39
SN7485N	.65	SN74221N	1.39
SN7486N	.39	SN74251N	.95
SN7489N	1.75	SN74273N	1.05
SN7490N	.39	SN74279N	.89
SN7491N	.65	SN74283N	2.15
SN7492N	.52	SN74284N	3.90
SN7493N	.49	SN74285N	3.90
SN7494N	.72	SN74290N	1.25
SN7495N	.65	SN74298N	.95
SN7496N	.72	SN74365N	.68
SN7497N	3.10	SN74366N	.68
SN74100N	.99	SN74367N	.79
SN74107N	.32	SN74368N	.79
SN74109N	.53	SN74390N	1.90
SN74116N	1.95	SN74393N	1.90
SN74121N	.29	SN74490N	1.90
SN74122N	.39		

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CD4000	.29	CD4093	.99
CD4001	.29	CD4094	2.95
CD4002	.29	CD4098	2.49
CD4006	1.39	CD4099	2.25
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CD4010	.59	MC14412	12.95
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CD4013	.49	CD4501	.39
CD4014	1.39	CD4502	1.65
CD4015	1.39	CD4503	.69
CD4016	.59	CD4505	8.95
CD4017	1.19	CD4506	.75
CD4018	1.19	CD4507	.95
CD4019	.49	CD4508	3.95
CD4020	1.19	CD4510	1.39
CD4021	1.49	CD4511	1.39
CD4022	1.29	CD4512	1.39
CD4023	.38	CD4515	3.95
CD4024	.79	CD4516	1.69
CD4025	.38	CD4518	1.39
CD4027	.79	CD4520	1.39
CD4028	.99	CD4555	4.95
CD4029	1.29	CD4556	.99
CD4030	.69	CD4566	2.25
CD4031	3.25	74C00	.39
CD4032	2.15	74C02	.39
CD4034	3.25	74C04	.39
CD4035	1.19	74C08	.49
CD4037	1.95	74C10	.49
CD4040	1.29	74C14	1.65
CD4041	1.25	74C20	.39
CD4042	.99	74C30	.39
CD4043	.99	74C32	.99
CD4044	.99	74C42	1.85
CD4046	2.25	74C48	2.39
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CD4048	.69	74C74	.99
CD4049	.69	74C85	2.49
CD4050	.69	74C89	4.95
CD4051	1.10	74C90	1.85
CD4052	1.10	74C93	1.85
CD4053	1.10	74C95	1.85
CD4055	3.95	74C107	1.19
CD4056	2.95	74C151	2.49
CD4059	9.95	74C154	3.50
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CD4069	.35	U74CC161	2.30
CD4070	.69	74C163	2.39
CD4071	.35	74C164	2.39
CD4072	.35	74C173	2.59
CD4073	.35	74C174	2.75
CD4075	.35	74C175	2.75
CD4076	1.29	74C192	2.39
CD4077	.35	74C193	2.39
CD4078	.35	74C195	2.39
CD4081	.35	74C922	7.95
CD4082	.35	74C923	6.95
CD4085	1.95	MM80C95	1.50
CD4089	2.95	MM80C97	1.25

74LS00

74LS00N	.35	74LS164N	1.19
74LS01N	.28	74LS165N	.89
74LS02N	.28	74LS166N	2.48
74LS03N	.28	74LS168N	1.89
74LS04N	.39	74LS169N	1.89
74LS05N	.28	74LS170N	1.99
74LS08N	.39	74LS173N	.89
74LS09N	.39	74LS174N	.99
74LS10N	.28	74LS175N	.99
74LS11N	.39	74LS181N	2.20
74LS12N	.39	74LS190N	1.15
74LS13N	.47	74LS191N	1.15
74LS14N	1.25	74LS192N	.98
74LS15N	.39	74LS193N	.98
74LS20N	.26	74LS194N	1.15
74LS21N	.38	74LS195N	.95
74LS22N	.38	74LS196N	.89
74LS26N	.39	74LS197N	.89
74LS27N	.39	74LS221N	1.49
74LS28N	.39	74LS240N	2.99
74LS30N	.26	74LS241N	2.49
74LS32N	.39	74LS242N	2.29
74LS37N	.79	74LS243N	2.29
74LS38N	.39	74LS244N	2.95
74LS40N	.26	74LS245N	8.95
74LS42N	.79	74LS247N	1.10
74LS47N	.79	74LS248N	1.10
74LS48N	.79	74LS249N	1.69
74LS51N	.26	74LS251N	1.79
74LS54N	.35	74LS253N	.98
74LS55N	.35	74LS257N	.98
74LS73N	.45	74LS258N	.98
74LS74N	.59	74LS259N	2.95
74LS75N	.68	74LS260N	.69
74LS76N	.45	74LS261N	2.49
74LS78N	.65	74LS266N	.59
74LS83AN	.99	74LS273N	1.75
74LS85N	1.19	74LS275N	4.40
74LS86N	.45	74LS279N	.59
74LS90N	.75	74LS283N	1.10
74LS92N	.75	74LS290N	1.29
74LS93N	.75	74LS293N	1.95
74LS95N	.88	74LS295N	1.10
74LS96N	.98	74LS298N	1.29
74LS107N	.45	74LS324N	1.75
74LS109N	.45	74LS347N	1.95
74LS112N	.49	74LS348N	1.95
74LS113N	.49	74LS352N	1.65
74LS114N	.55	74LS353N	1.65
74LS122N	.55	74LS363N	1.49
74LS123N	1.19	74LS365N	.99
74LS124N	1.35	74LS366N	.99
74LS125N	.89	74LS367N	.99
74LS126N	.89	74LS368N	.99
74LS132N	.79	74LS373N	2.75
74LS136N	.59	74LS374N	2.75
74LS138N	.89	74LS375N	.69
74LS139N	.89	74LS377N	1.95
74LS145N	1.25	74LS385N	1.95
74LS148N	1.49	74LS386N	.65
74LS151N	.79	74LS390N	1.95
74LS153N	.79	74LS393N	1.95
74LS154N	2.49	74LS395N	1.70
74LS155N	1.19	74LS399N	2.95
74LS156N	.99	74LS424N	2.95
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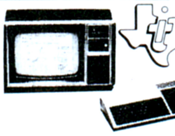

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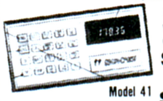

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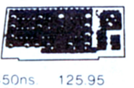

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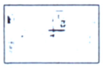

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$699.00

★ Memory Mapping ★ Low Power
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Recommended by Alphamicrosystems

	250 ns.	450 ns.
8K Static	$209.00	$189.00
16K Static	$449.00	$399.00
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Model DP-8000 compact, impact, parallel or serial. Sprocket feed, 80 cols, 84 lines/min., bi-directional.

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MODEL NO.	DESCRIPTION	PRICE
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9611	Arith. Proc/Memory Module	495.00
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9617	EPROM Programming Head	250.00
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9622	Serial-Parallel I/O Module	325.00
9627	16K Static RAM Module 470ns	395.00
9629	32K Static RAM 450ns	695.00
9629A	32K Static RAM 200ns	895.00
9630	Card Extender	68.00
9640	Multiple Programmable Timer	395.00
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UNPOPULATED BOARDS (Also Available)

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★ Bank Selectable ★ Uses 4116 200 ns.
★ Write Protect ★ Power 8VDC. ±16VDC
★ Phantom ★ Up to 4 MHz

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Supplied with documentation. Power input: 115VAC ± 10%, 60Hz, 200 Watts. Printer platen, 15" wide. Desk size: 20" x 35" wide x 23" deep. Excellent condition. Guaranteed. Shpg. Wt. 150 lbs.

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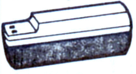

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9x7, 125 cps 136 characters/line
Full 15" width. Super for business applications requiring large IBM format paper.

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★ On board 2708 ★ 2708 included (450ns.)
★ Power on jump ★ completely socketed

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8 slot expandable w/9 conn.

reg $69.95 .... NOW $52.95

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Bell 103
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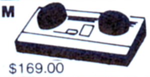

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74C923	9.95

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21L02 450ns	1.30	1.25	.99
21L02 250ns	1.59	1.55	1.15
2111	3.75	3.65	3.55
2112-1	2.95	2.85	2.65
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2114L-250ns (4045)	8.95	7.50	6.50
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8	.15	.32	.45
14	.19	.36	.59
16	.20	.38	.62
18	.24	.59	.84
20	.29	.69	.99
22	.24	.79	1.10
24	.38	.85	1.20
28	.43	1.10	1.49
36	.58	1.25	1.69
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Teletype Model 43	1349	1150
HiPlot Plotter	1085	899
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Intertube II	895	784
Atari 800	999	899
Atari 400	549	499
TI 99/4	1150	1099
Leedex 12" Monitor	149	139
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Trencom T-100	375	349
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Sanyo 9" Monitor	220	169
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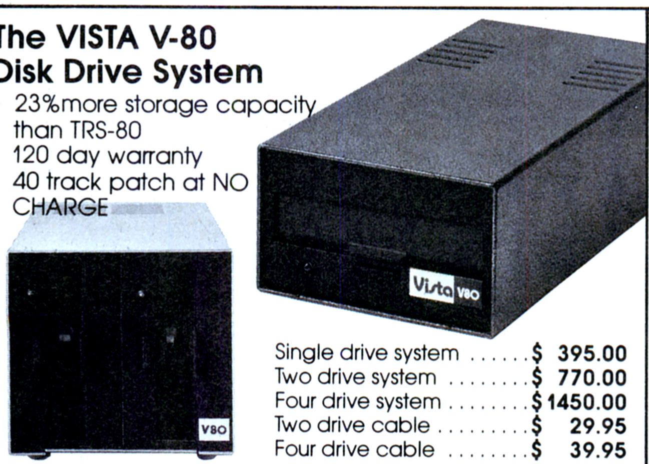

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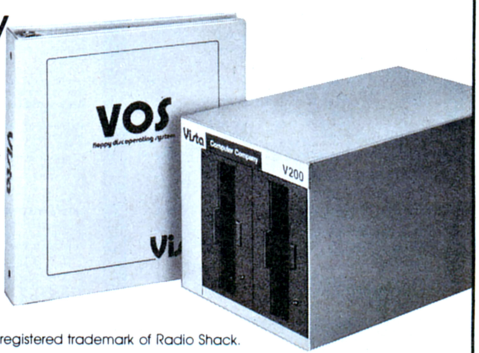

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FOR SALE: Heathkit ET-3400 Microprocessor Trainer with EE-3401 self-instruction program. Extra memory chips and components. Assembled and in excellent condition. Asking $150. William Porti, Second St, Evans City PA 16033, (412) 538-5454.

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WANTED: Copy of Z80 Assembler listing from BYTE Nybbles library. Harlan Michael, 315 Valley Vista Dr, Jackson MS 39211, (601) 982-6533 days or (601) 956-5268 evenings.

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WANTED: Ohio Scientific Superboard IIs with all manuals and documentation, up to $150 paid depending on year and condition. Send year and condition for my offer. For Sale: TI 99/4 microcomputer. Paid $1150, first certified check for $1075 gets it. Brand new and still in original carton. Or will trade TI 99/4 for $950 plus Ohio Scientific Superboard II in good condition. Gregg Beasey, 15 Cardinal Ln, East Islip NY 11730.

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WANTED: I have a small amount of 8080 equipment (processor, a few support chips) and a large supply of other stuff (74xx, MM3501, etc) and would like to buy or trade for anything 6800ish (processor, bareboard, support, etc). Give a hand to an uprooted American. R M Bownes, 146 Warren Rd, Donaghdee County Down, NORTHERN IRELAND BT21 OPQ. PS: Please use airmail, it's a lot faster.

WANTED: Drawings and schematics for making an electrical sleep device, and other schematics for experimental hypnosis. K de Groot, P-Lastmanstr. 7, Helmond, HOLLAND.

WANTED: Heathkit Microprocessor Trainer ET-3400 and Memory I/O Accessory ETA-3400 for use with Heathkit Microprocessor Course. Will trade for Teletype printer parts, and/or cash. Please write and give details (ie: assembled/unassembled and if the unit(s) are operational). George Kelm, POB 160, Yap Island GU 96943. First class mail for fastest reply, US Domestic Post Office rates.

February BOMB Results
Graph Theory

Readers of BYTE expressed a burning interest in "A Computer-Controlled Wood Stove" by Steve Ciarcia (page 32). Steve won first place in the voting, his fourth first-place finish in as many months. Second place in the tally went to John A Lehman for "A Financial Analysis Program" (page 192). Judging from comments written on the BOMB cards, many readers were fascinated by an example of the balance sheet for MITS, Inc. Third place was taken by Ted Carter for "Implementing Dynamic Data Structures with BASIC Files" (page 92). Fourth place was taken by Robert A Morris for "Comparison of Some High-Level Languages" (page 128).

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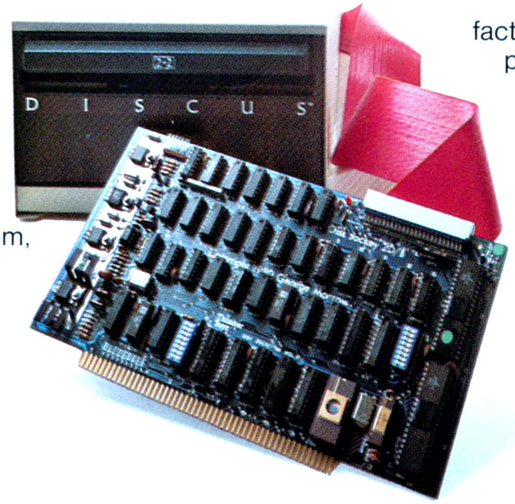
Now you can use your S-100 system to tackle big jobs. Because the DISCUS™ 2+2 Quad-Density Disk System puts 1.2 megabytes of fast-access memory on your side for just $1545.00 complete.

With the DISCUS™ 2+2 System, complete means complete.

You get a full-size (IBM-compatible 8″) double-sided/double-density disk drive, factory mounted in a cabinet with power supply, fully-buffered S-100 single-board controller, and interconnecting cables. All fully assembled, system-tested and fully warranteed.

You get the speed and efficiency of 1.2 megabyte-per-diskette memory... and you get it for 0.13¢ per byte.



Side Two

The DISCUS™ 2+2 Quad-Density Software

1.2 megabyte quad-density hardware is only one side of the story. The DISCUS™ 2+2 System price includes all the fully-interfaced, high-performance software you need to take full advantage of your quad capacity.

The system includes our exclusive BASIC-V™ virtual disk BASIC, which allows you to address your quad-density diskettes as easily as main memory. The operating system you get is the widely accepted CP/M* 2.1. And you get our powerful DISK-ATE text editor/assembler; The most advanced software development tool available.

Micro-Soft BASIC 5.1 and Micro-Soft FORTRAN are available as options. Both run under CP/M* 2.1.

Check out the full system price of DISCUS™ 2+2 Quad against any other floppy disk system at your local computer store. At $1545.00, we think you'll take sides with DISCUS™ 2+2.

If your dealer doesn't carry THINKER TOYS products, write MORROW DESIGNS Inc., 5221 Central, Richmond, CA 94804. Or call (415)524-2101 9-5 weekdays (Pacific Time).

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*CP/M is a trademark of Digital Research.

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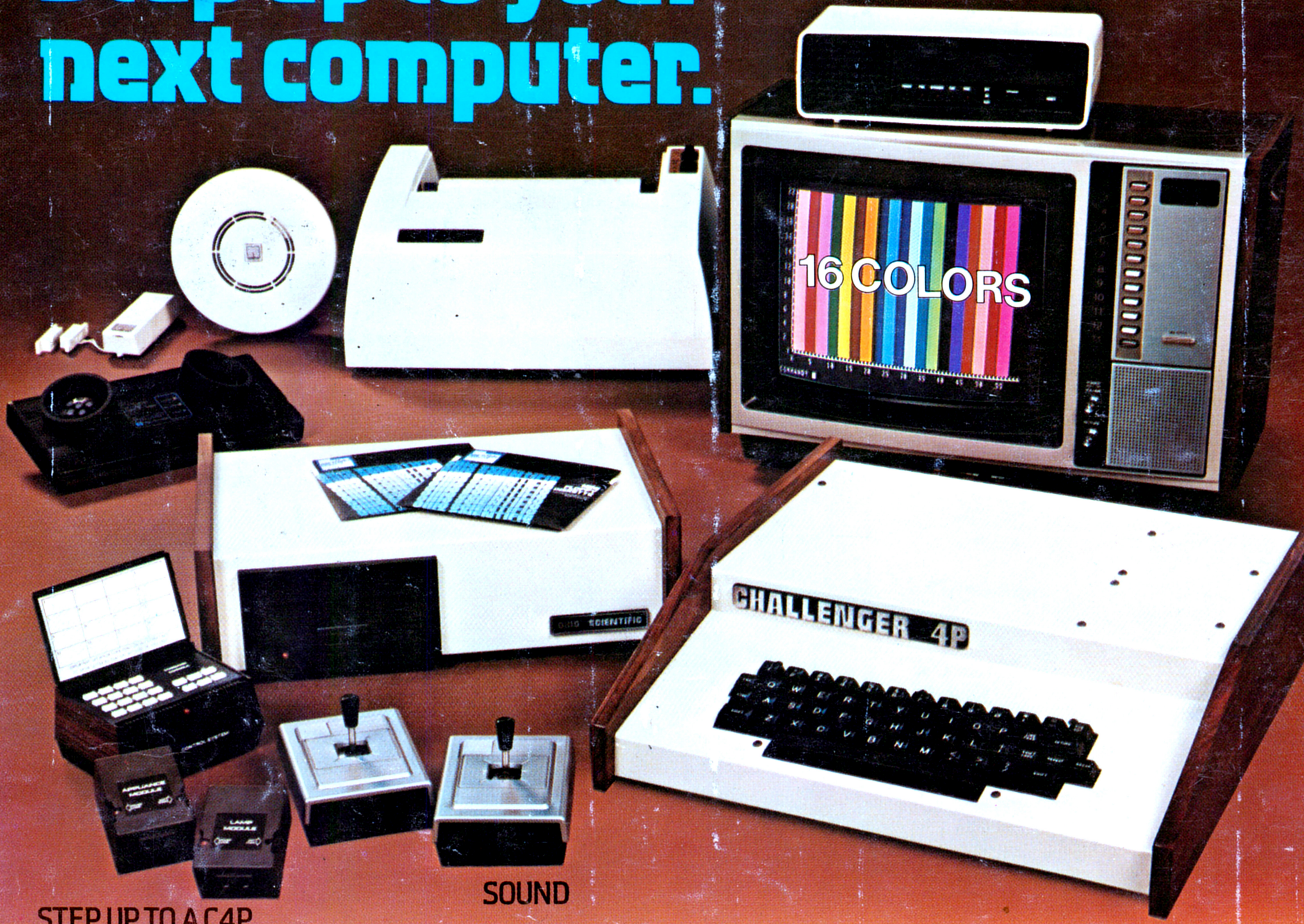

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8K BASIC-in-ROM, 8K of static RAM and audio cassette interface. Can be directly expanded to 32K static RAM and two mini-floppy disks.

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Computers come with keyboards and floppies where specified. Other equipment shown is optional.

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